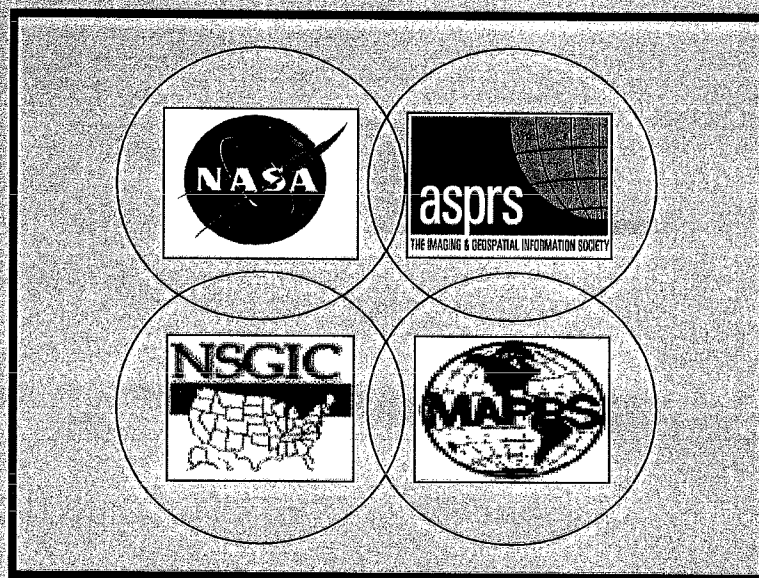


Highlights

The 10-Year Remote Sensing Industry Analysis



March 21, 2002



Background

In August 1999, ASPRS and NASA's Commercial Remote Sensing Program (CRSP) entered into a 5-year Space Act Agreement (SAA), combining resources and expertise to:

- Baseline the Remote Sensing Industry (RSI)
- Develop a 10-Year RSI market forecast
- Provide improved information for decision makers
- Develop attendant processes

Analysis Plan

**Phase I Characterization and Baseline
Forecast of the Industry (Dec 2000)**

**Phase II Characterization of
Customers/Users and
Determination of Their
Needs/Requirements (April 2002)**

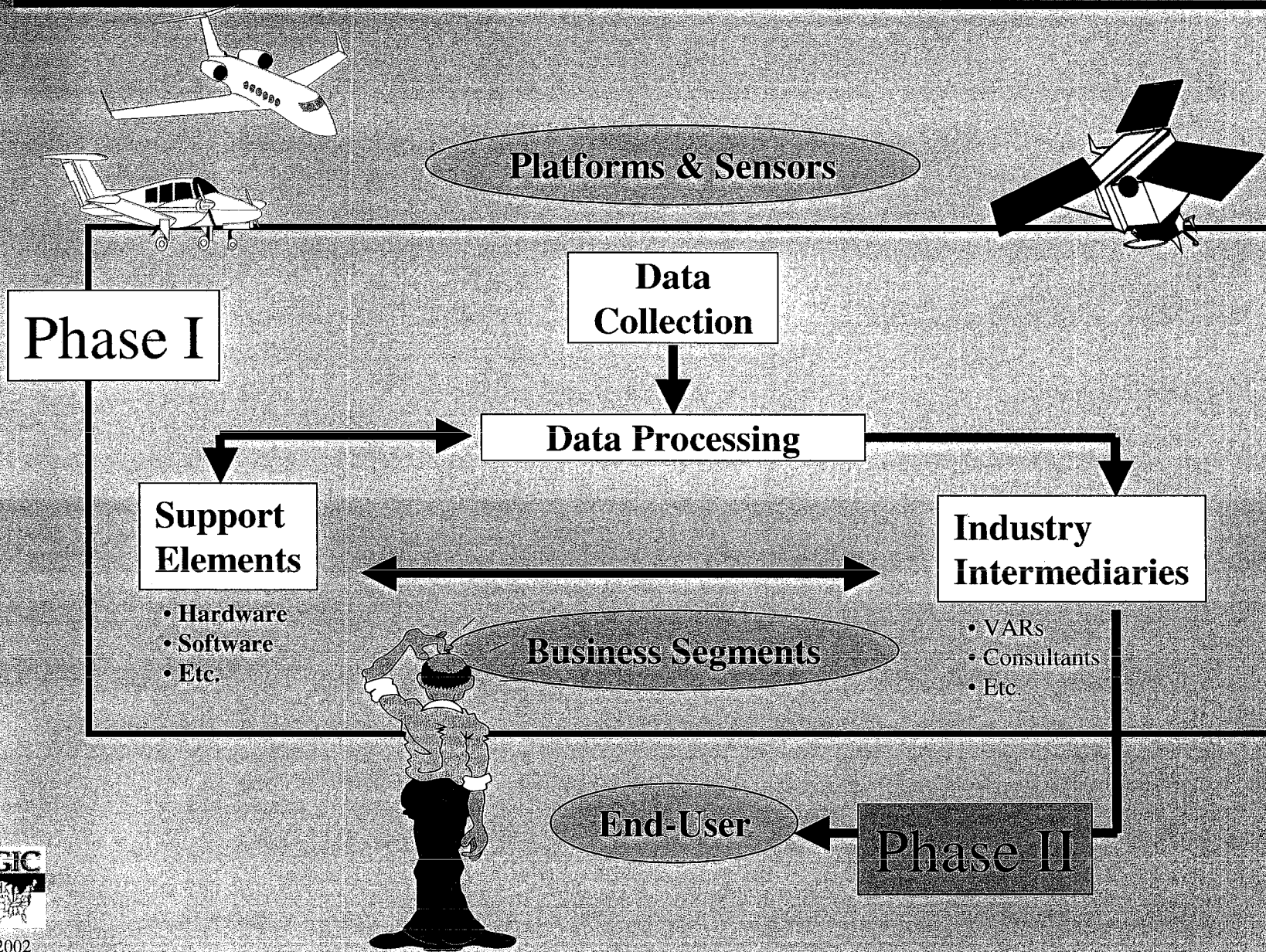
**Phase III Validate I and II (Dec 2003)
Technology Assessment**

Phase IV Market Forecast (Dec 2004)





Remote Sensing Industry Definition



3/19/2002



Part II 3



Analysis Participants

- NASA*
- NOAA*
- USGS*

- ASPRS*
- MAPPS*
- NSGIC*

- American Forests
- Autometrics
- Eaglescan
- EarthData
- Geomatics
- Kodak
- Landcare Avn.
- Leading Edge
- Lockheed Martin
- PAR
- Pictometry
- RAND
- Spencer-Gross
- SPOT
- Space Imaging

- RIT
- University of Arizona*
- University of Missouri*
- University of Southern Mississippi*
- University of Utah*

Analysis by the Industry For the Industry

(Not by an outside agent for profit)



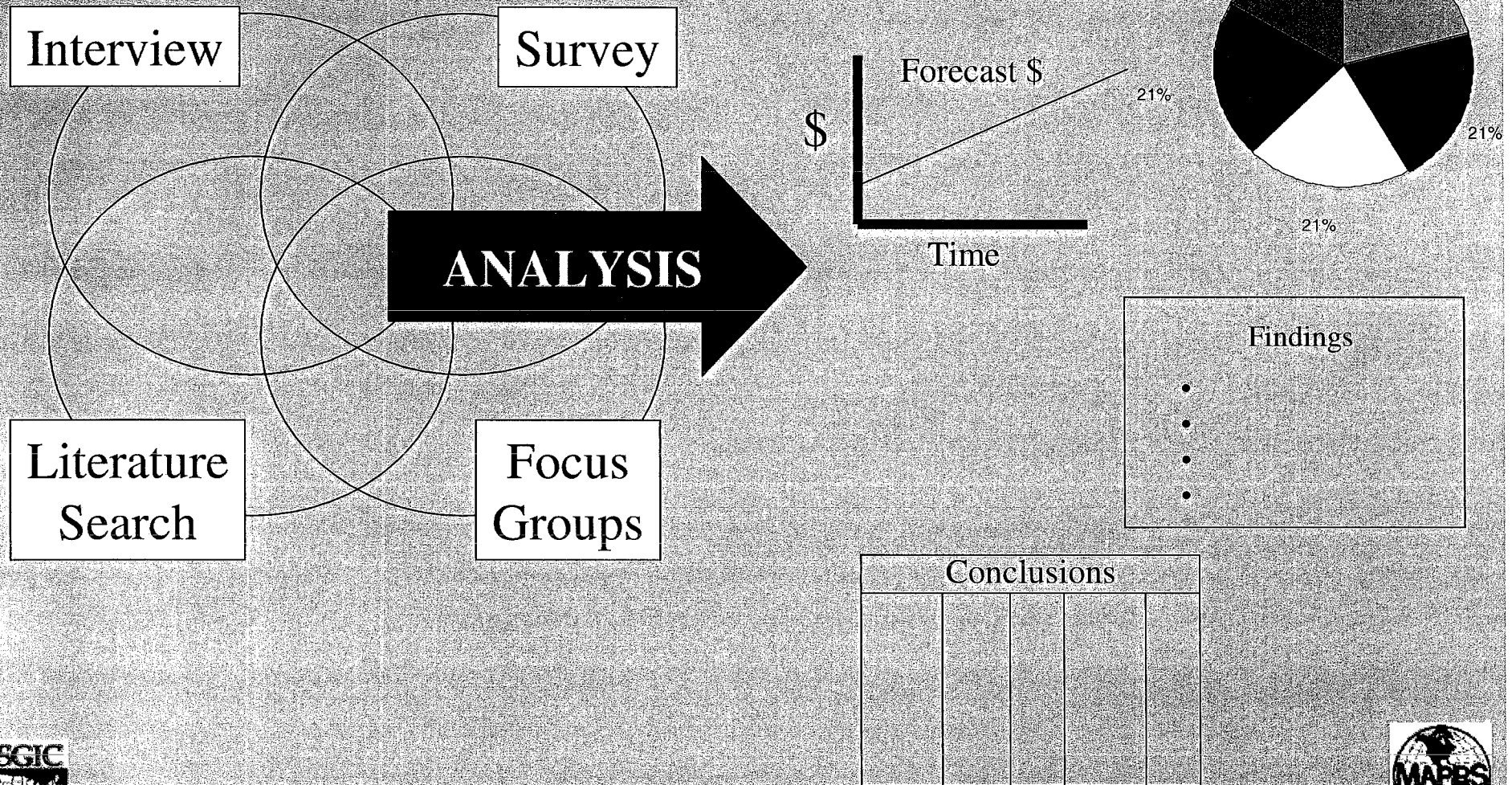
3/19/2002



Part II 4



Analysis Process





Assumption: A Representative Sample

✓ About 1,450 industry professionals

- **Phase I**

- 36 Interviews (commercial); 437 Survey Responses; Closed Envelope (43)

- **Phase II**

- 134 Interviews; 750 Surveys; 4 Focus Groups (@15 people per); Closed Envelope (42)

✓ Geographic Dispersion

✓ Participation

- Professional Assns. (ASPRS, MAPPS, NSGIC), Government Agencies, Private Companies

✓ Sector Coverage

- Academic, Commercial, and Government



Based on Phase II Survey Responses

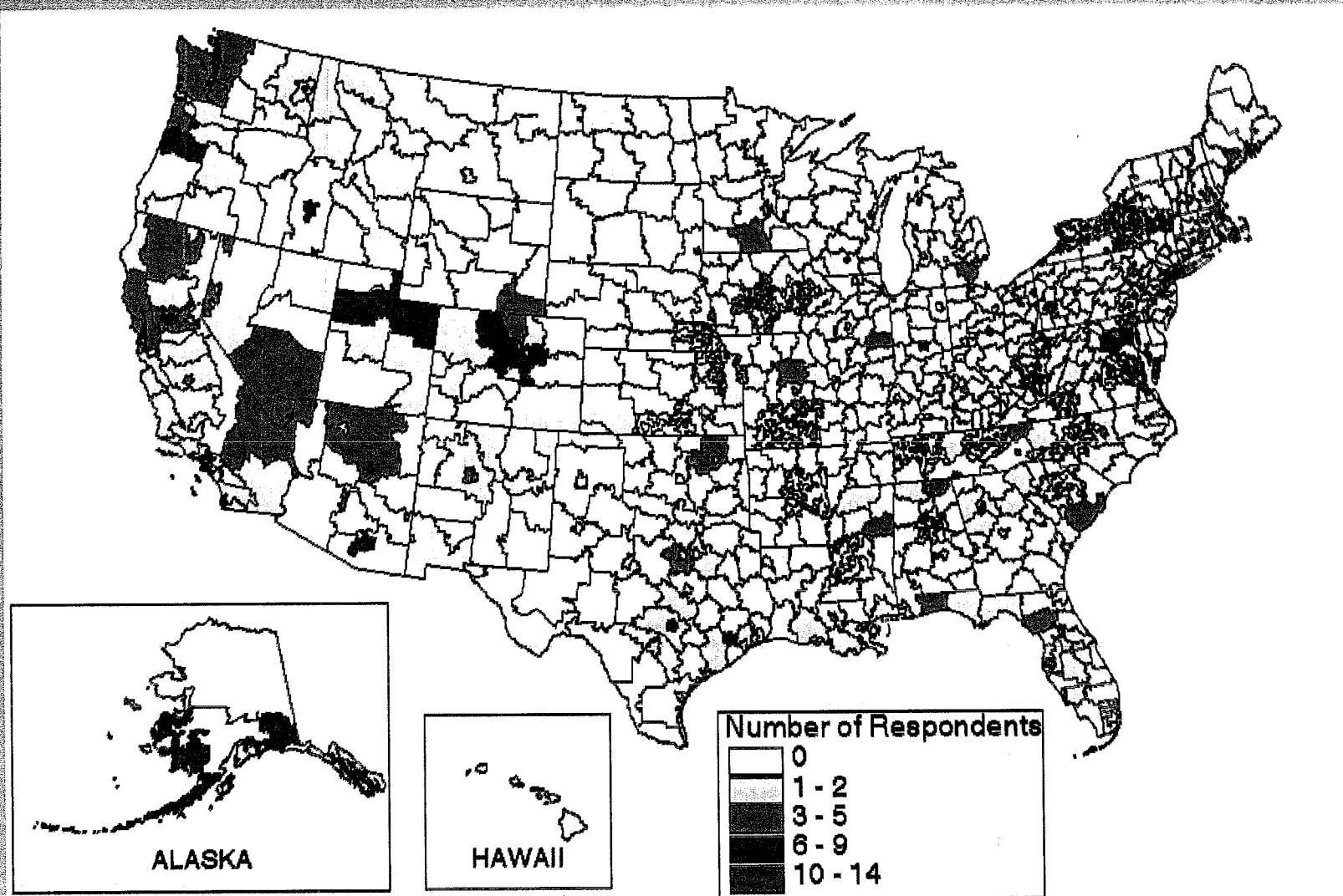
3/19/2002



Part II 6



Respondent Zip Code Distribution All Sectors



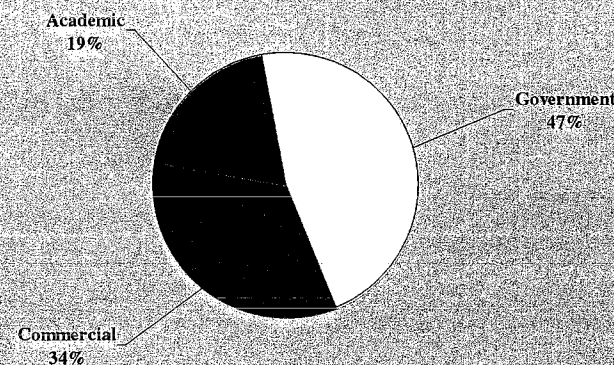
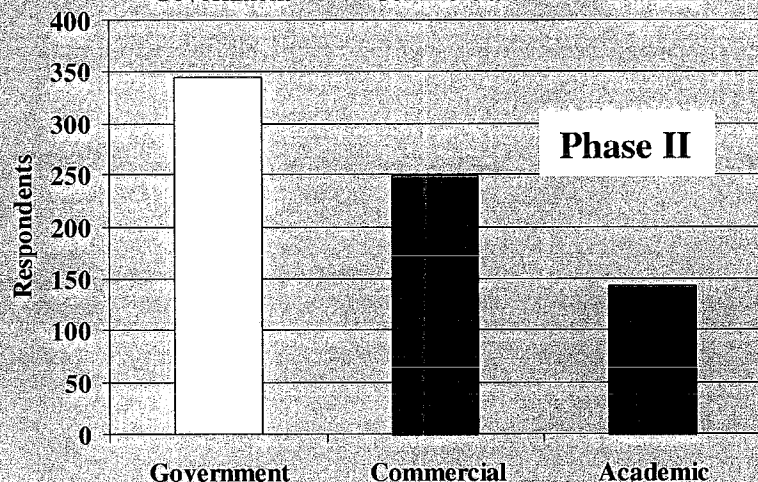
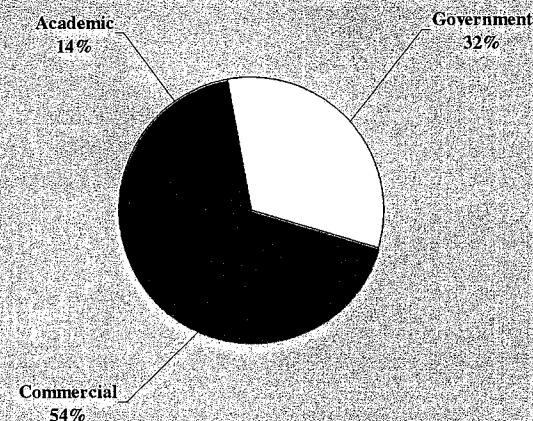
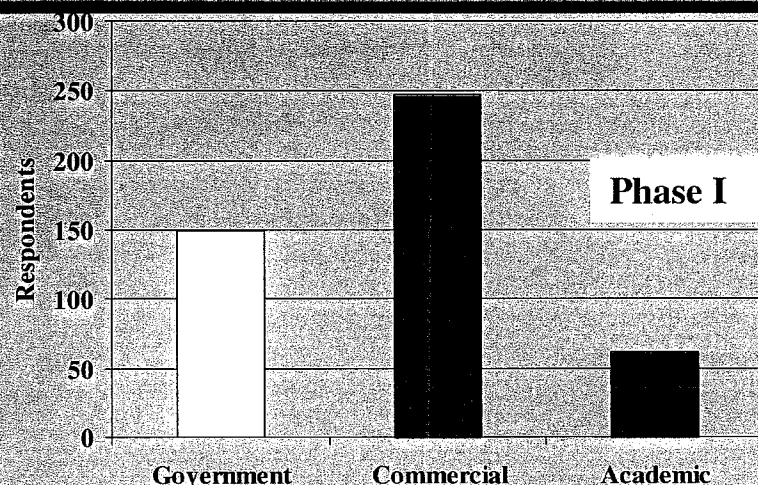
Based on Phase II Survey Responses

3/19/2002





Respondents by Industry Sector



We believe:

- The difference is in the sampling technique used
- Phase II is more representative of the Industry

Based on Phase II Survey 735 Responses



3/19/2002



Part II 8



Primary Job Titles by Sector

ACADEMIA	
Academic Administrator	4
Professor	38
Associate Professor	16
Assistant Professor	22
Instructor	5
Adjunct Faculty Member	1
Laboratory Director	8
Research Staff	28
Student	14

COMMERCIAL	
Owner	42
President	13
Top Level Manager	32
Senior Manager	26
Sales Manager	5
R&D Manager	8
Marketing Manager	2
Product Manager	12
Manager	21
Analyst	42
Engineer	22
Technician	7

GOVERNMENT	
Executive Director/Senior Manager	82
Research/Scientist	50
Program Staff	39
Professional Technical Staff	131
Technician	17

- A balanced cross-section of jobs/tasks in the industry



Based on Phase II Survey Responses

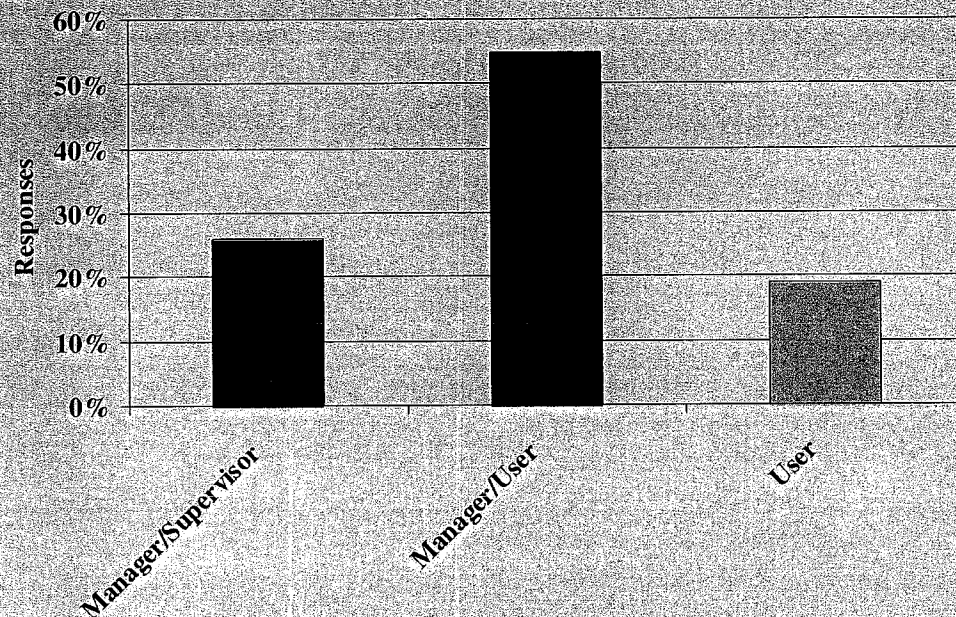
3/19/2002



Part II 9



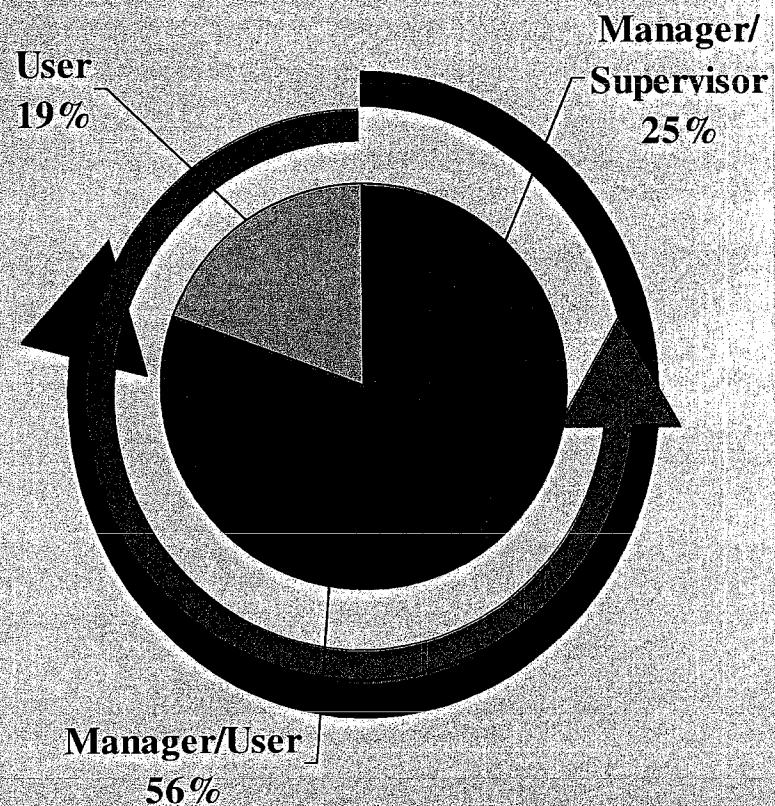
Manager and User Perspective



- **MANAGER/SUPERVISOR:** a person who can (influence) (spend) (allocate) (authorize) dollars to purchase/acquire remotely sensed data, information and/or software.

- **MANAGER/USER:** a person who can (influence) (spend) (allocate) (authorize) dollars to purchase/acquire remotely sensed data, information and/or software and works with said data, information and/or software.

- **END-USER:** a person whose job would entail working with remotely sensed data, information and/or software.

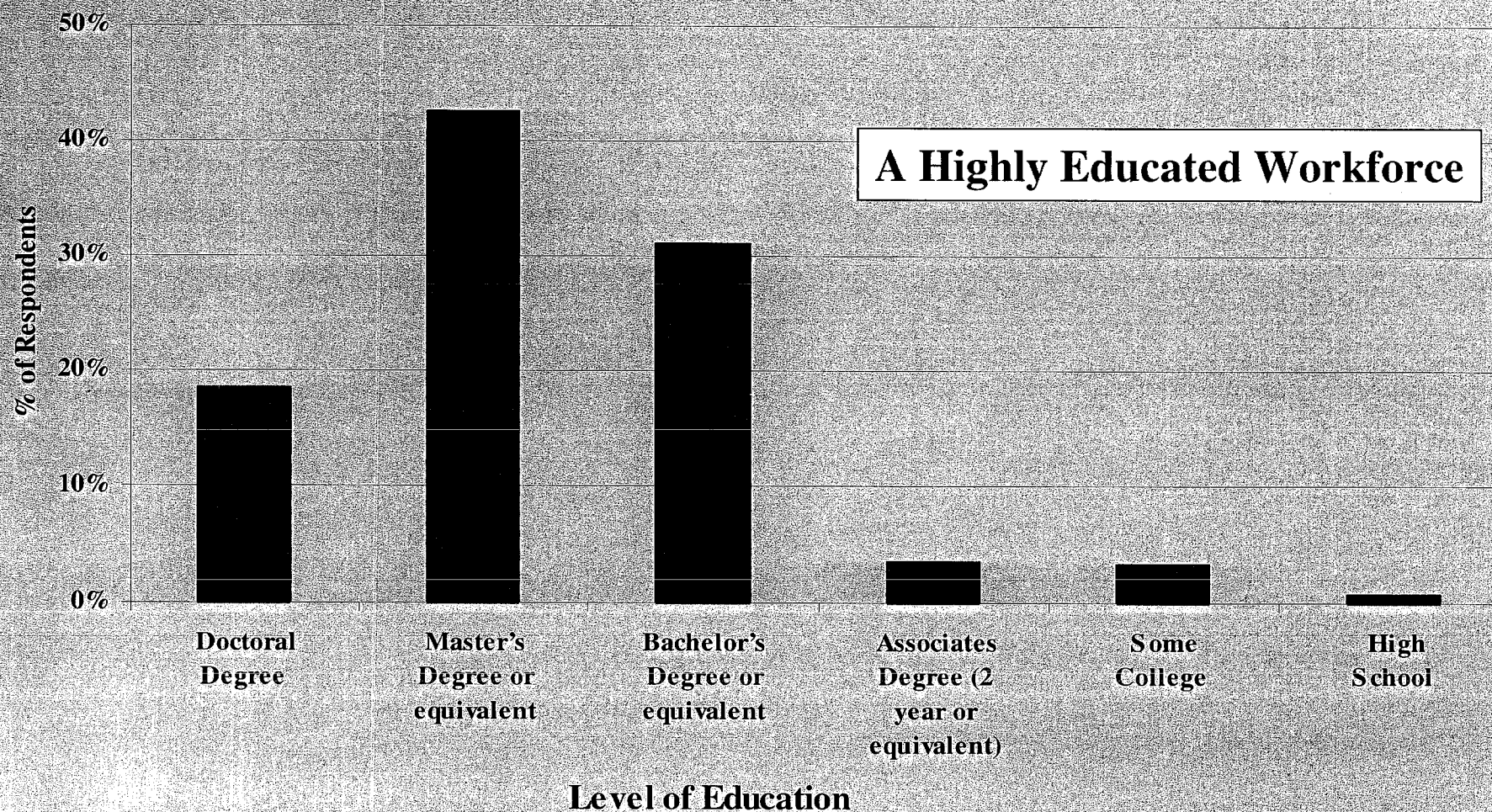


- **75% User Group**
- **81% Manager Group**





Level of Education



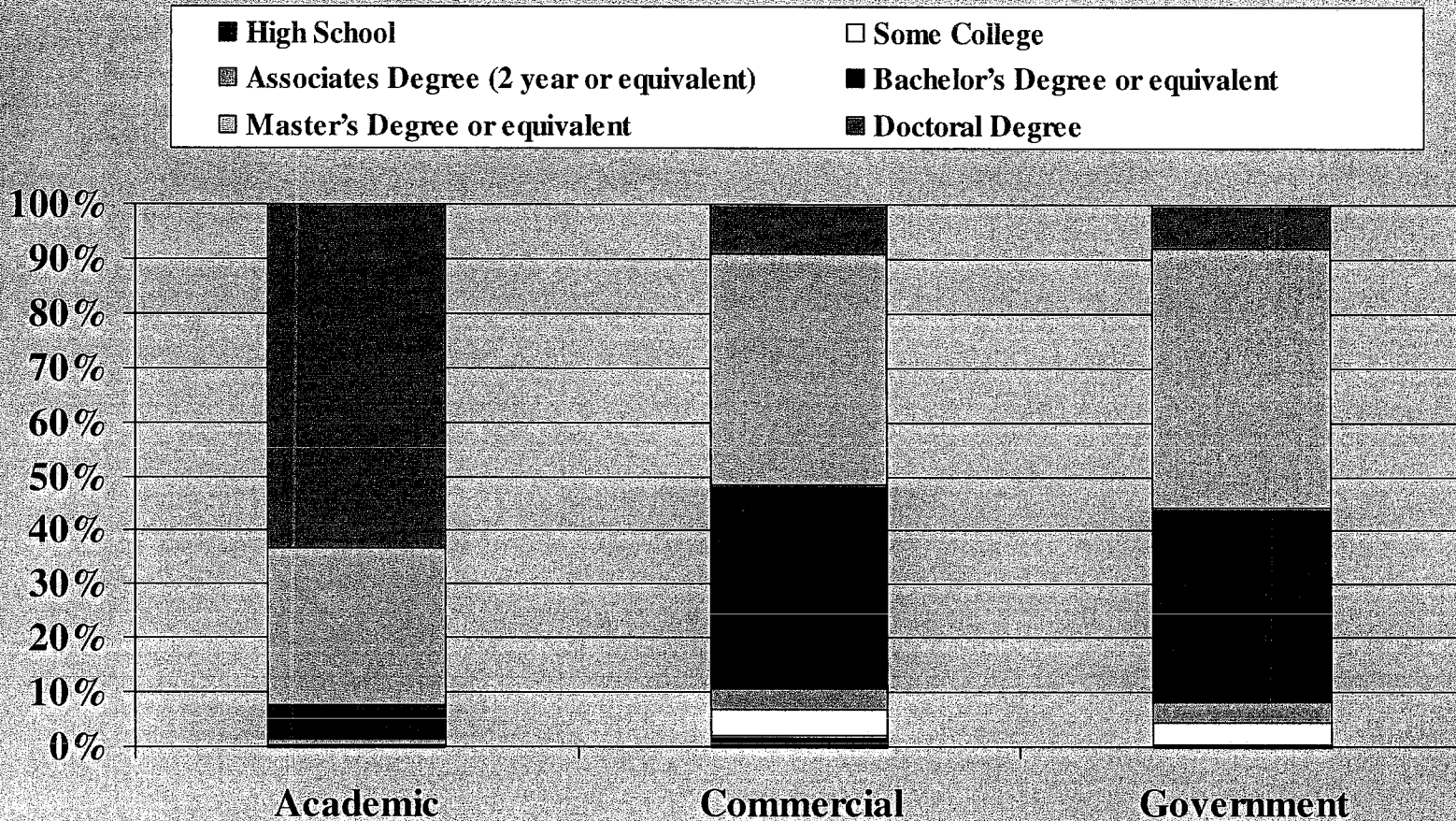
3/19/2002

Based on Phase II 731 Survey Responses: Doctoral Degree 136, Master's Degree or equivalent 312, Bachelor's Degree or equivalent 227, Associates Degree (2 year or equivalent) 26, Some College 24, High School 6, Other 0





Level of Education by Sector



- Greater than 90% have a 4-year college degree or better.
- Over 60% have a Masters degree or better.



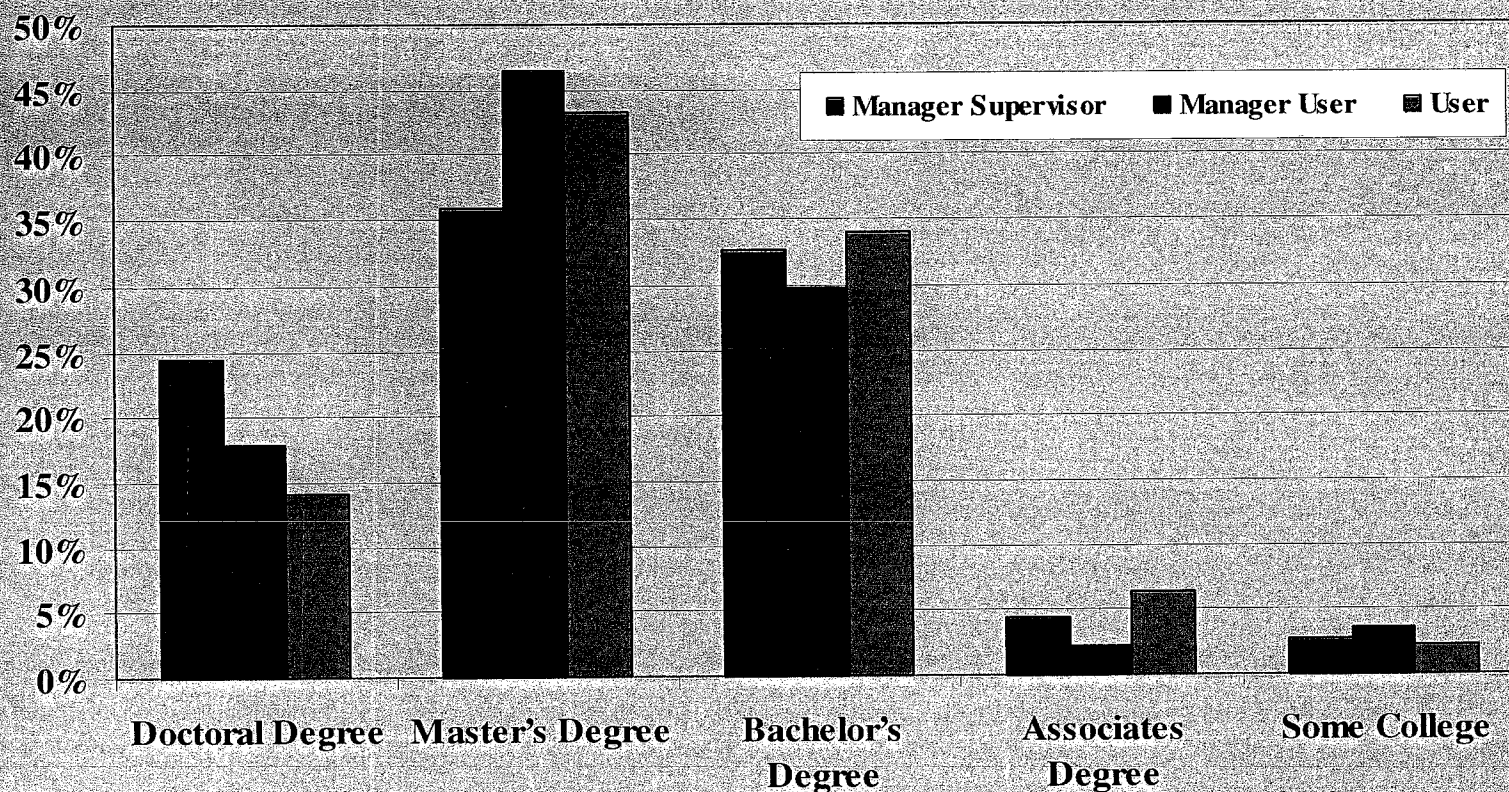
3/19/2002



Part II 12



Level of Education: Manager/User

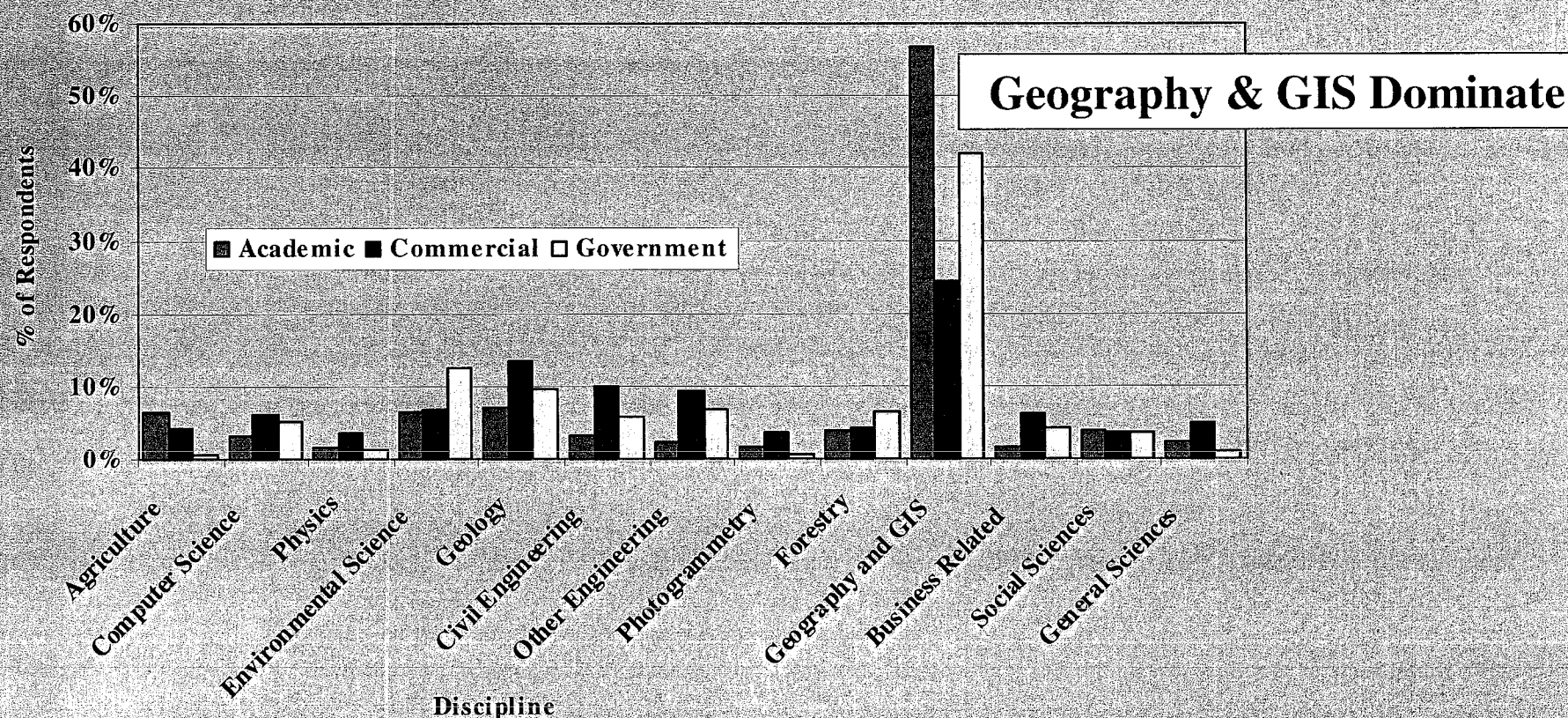


- Overall, there is good Manager-to-User balance in terms of level of education
- Manager Supervisors tend to have Doctoral more frequently
- Manager Users and Users tend to have Masters more frequently





Degrees by Discipline by Sector and Manager/User



- The “generalists” in remote sensing are degreed in Geography and GIS and are probably very mobile in the Remote Sensing Industry
- Other disciplines are probably more transportable outside Remote Sensing Industry





Formal Coursework in Remote Sensing

Regardless of discipline, about 60% have had course work related to remote sensing

- **Academic 75%**
- **Commercial slightly less than 50%**
- **Government nearly 60% of the respondents**

The current community of managers/users is both well-educated and generally knowledgeable about remote sensing



Based on Phase II Survey Responses

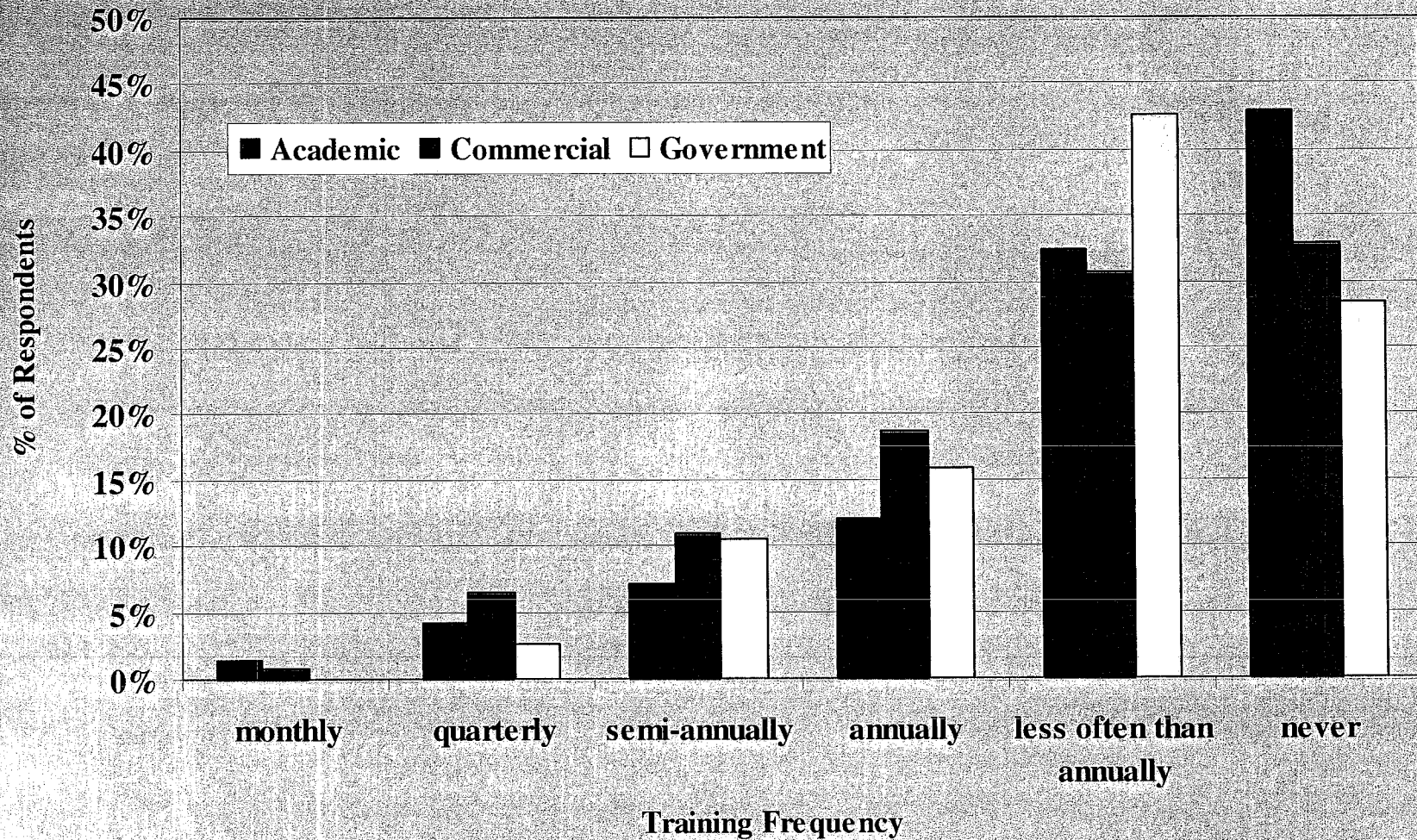
3/19/2002



Part II 15



Employer-Sponsored Training by Sector

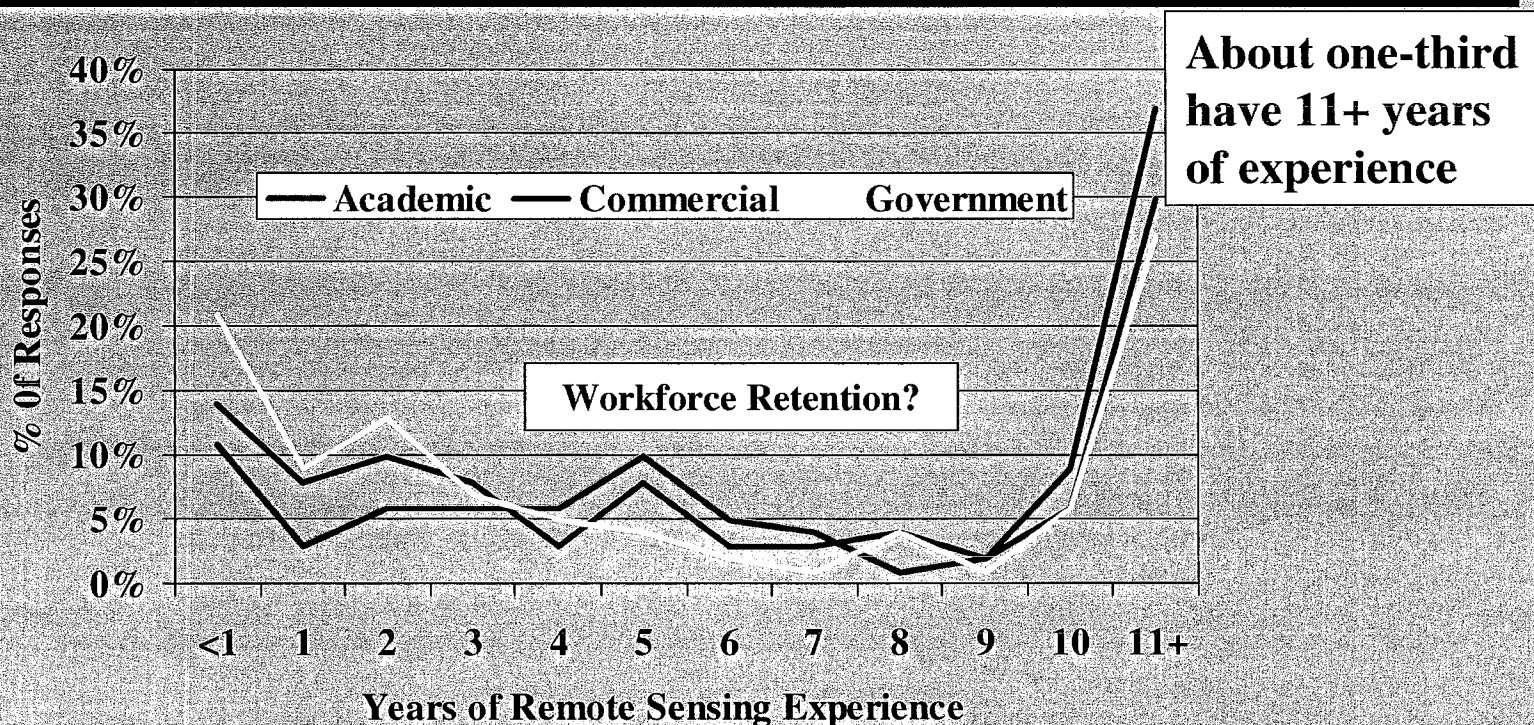


• Most employers do not have frequent training for employees.





Experience: Remote Sensing Industry

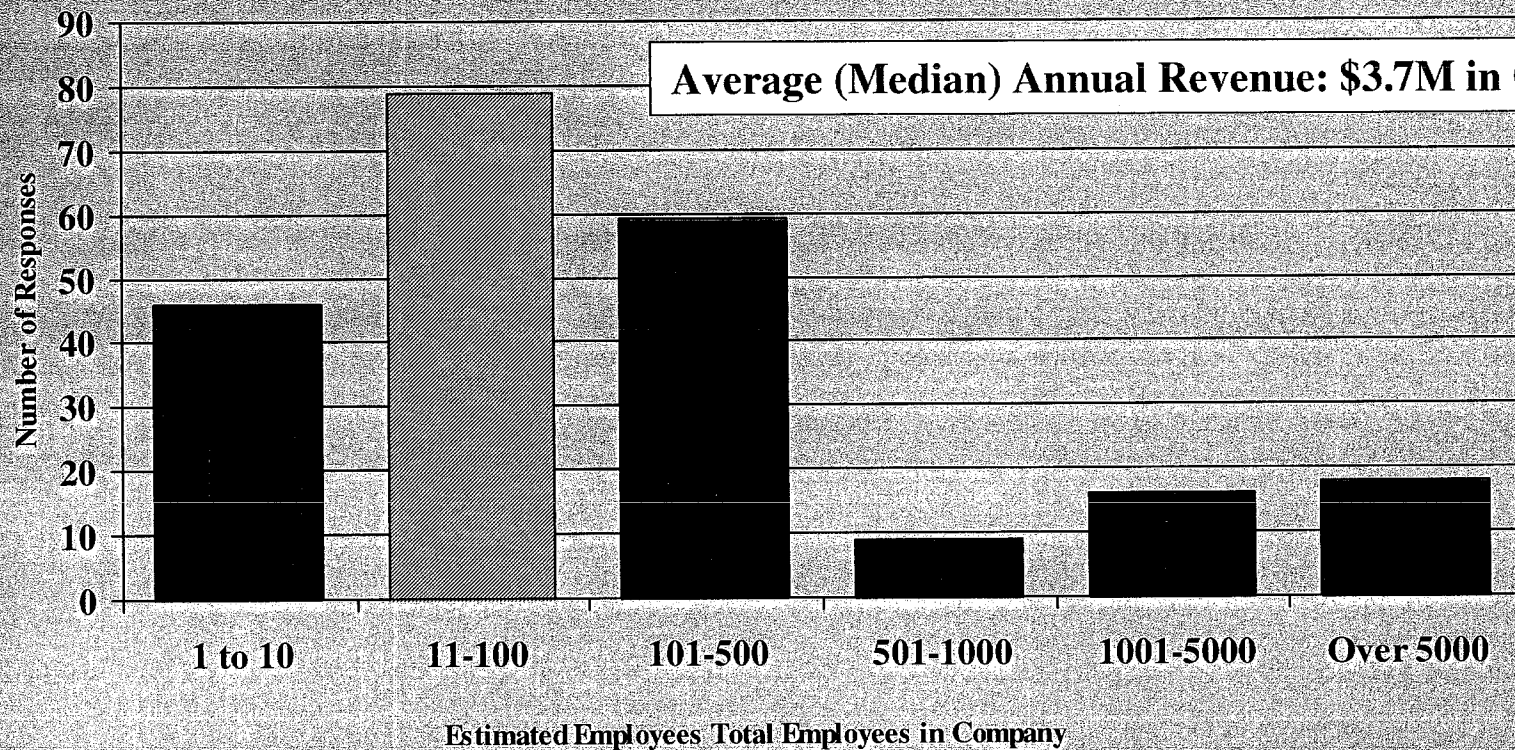


- A bi-modally distributed workforce
- Government has most “entry levels” (>20%) , but least with 10/11+ years of experience (<30%)
- Academia has nearly 40% with 11+ years experience
- Apparently, workforce retention is a key issue





Commercial Company Size

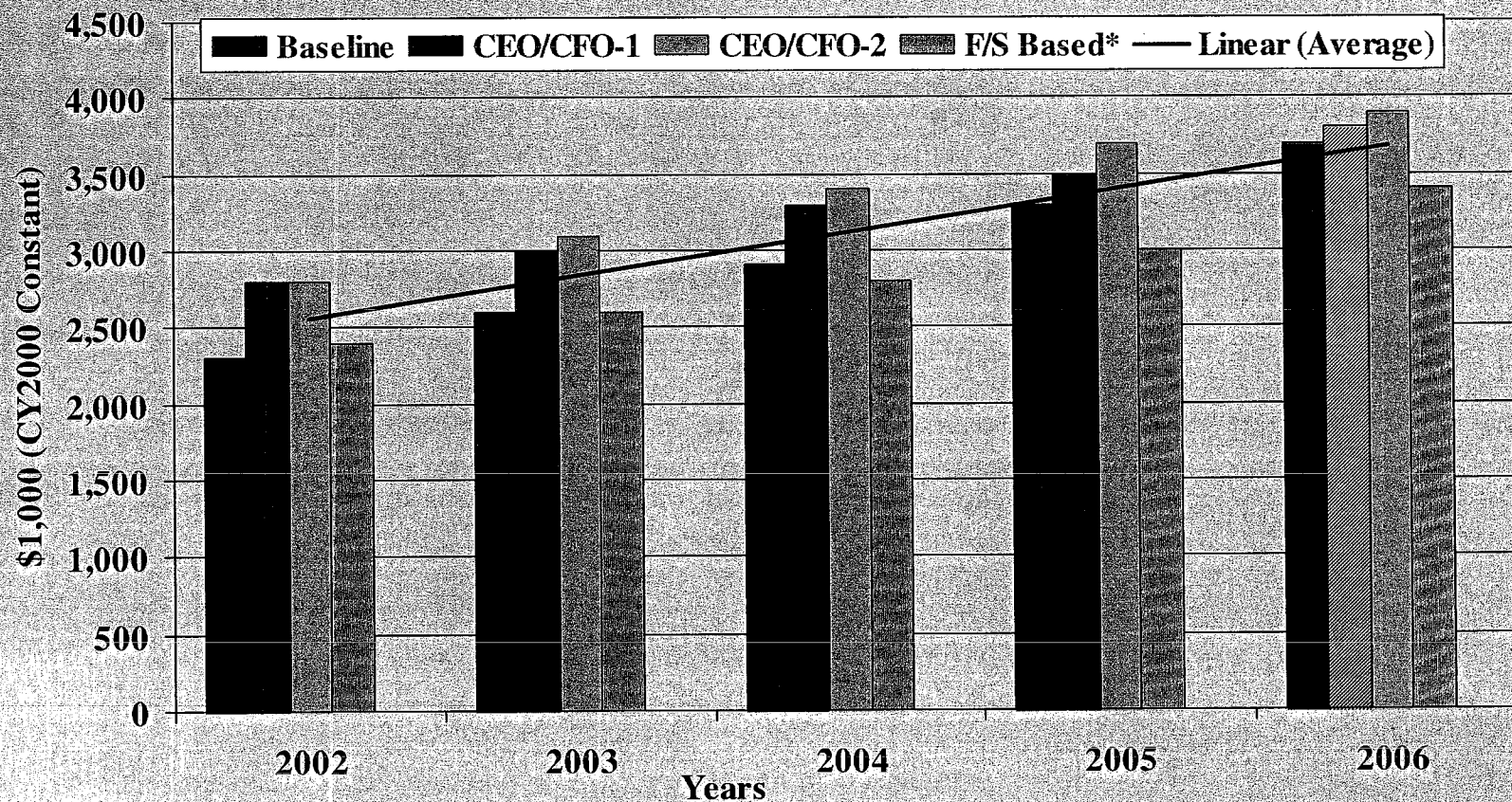


- ✓ This is a fragmented industry
- ✓ Smaller companies are in the majority
 - About 20% of respondents estimated at 10 or less employees
 - About 55% of respondents estimated at under 100 employees
 - (% < 50 ?)
 - Over 80% of respondents estimated at under 500 employees





U.S. Sales/Revenues Comparisons



- All are slightly different “counts”
- All are in the same “ballpark”
- *All predict growth (AAG= about 9%)*



3/19/2002

*Frost and Sullivan 2001

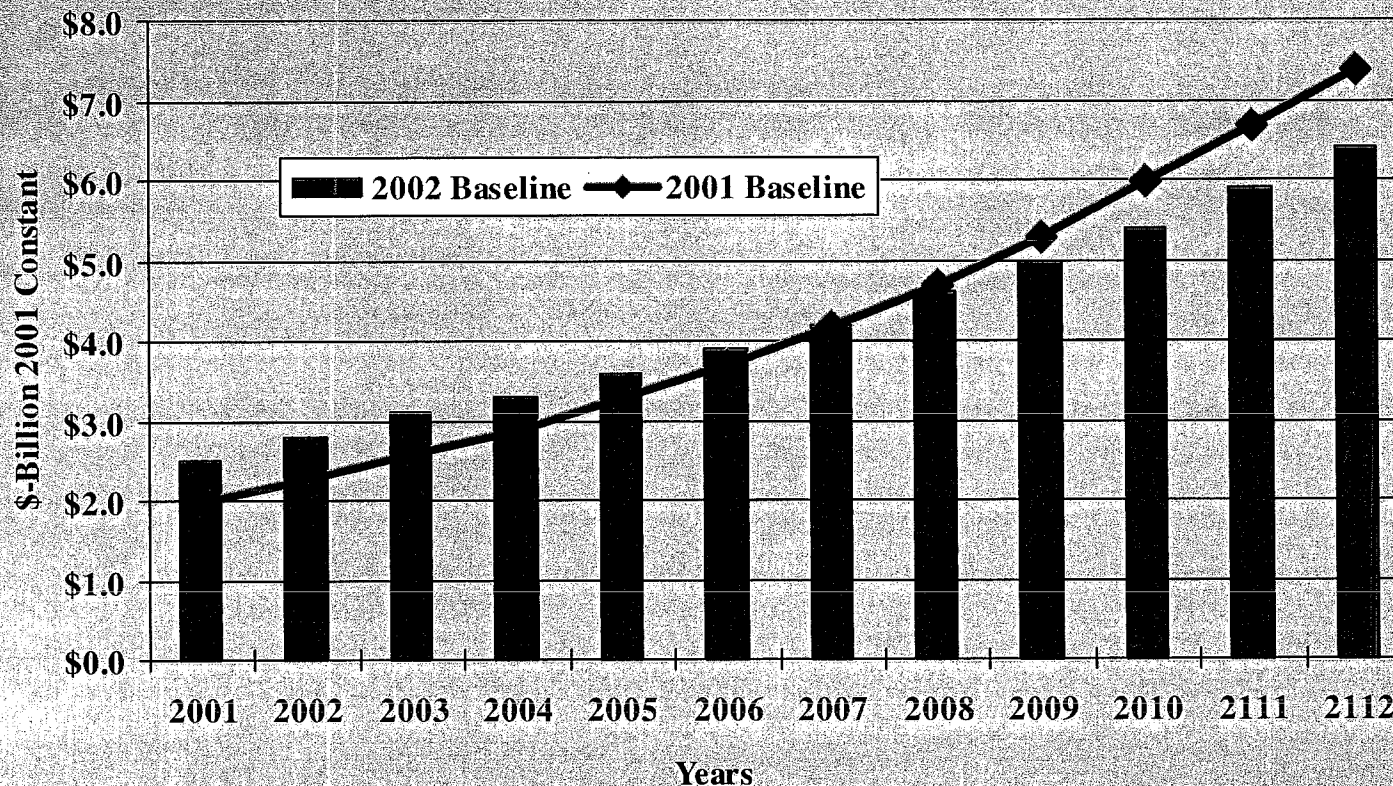


Part II 19



2002 Baseline Forecast

- Assume best insight comes from CEOs/CFOs and use their Expected Revenues and build revised baseline 2002 accordingly



Approach:

1. Average 2001 and 2002 CEO/CFO Expected Revenue estimates. Use to plot 2001-2006
2. Apply AAGR associated with those estimates to forecast 2007-2012



3/19/2002



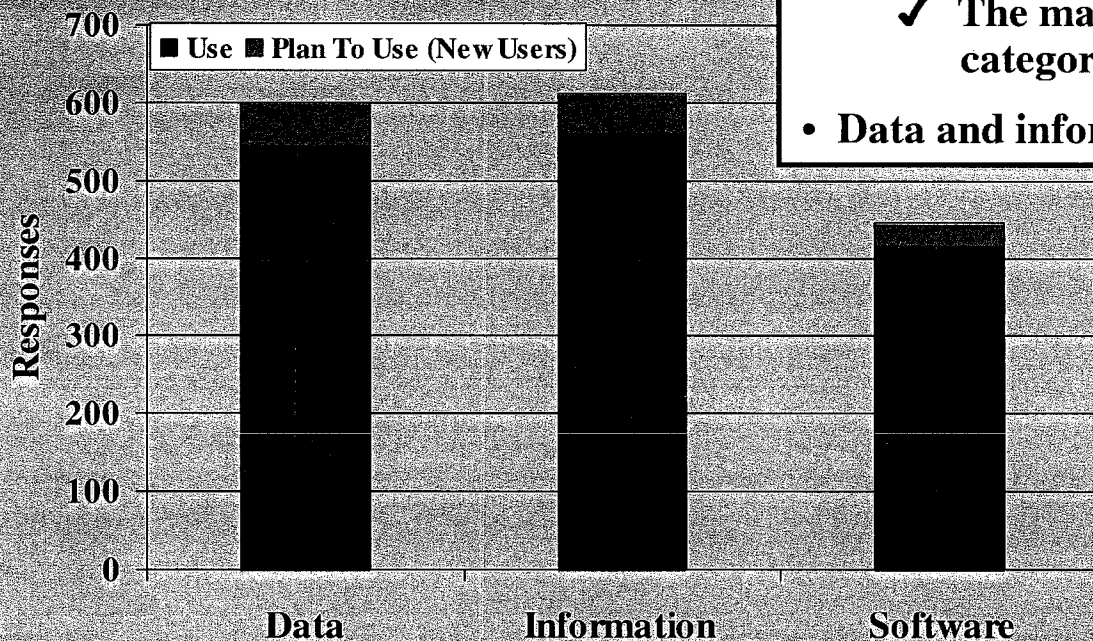
Part II 20



Use/Plan To Use Remote Sensing Data/Information/Software



- >735 Respondents; 1,600 responses
- ✓ The majority of respondents use at least two categories
- Data and information are used more than software



**Suggests more Data/Information
Users Considering Market Entry**

Estimated short-term growth: 9.0%

- Data: 10.0 %
- Information: 9.0 %
- Software: 7.0 %

DIS Use Patterns		
	Using	Planning to Use
Data	73	55
Information	74	19
Software	7	2
Data/Information	97	13
Data/Software	34	7
Information/Software	17	1
DIS	356	19
Totals	658	116



Based on Phase II Survey Responses

3/19/2002



Part II 21



Analysis of Aerial Market Drivers*

Drivers	Impact			
	Near Term (1-2 yrs.)	Mid Term (3-4 yrs.)	Far Term (5-7 yrs.)	Analysis
Urban Growth	High	High	High	Agree
Decreasing Data Costs	Medium	Medium	High	M, H, H
Demand for High Spatial Resolution	High	Medium	Medium	H, H, M
Data and Software Licensing Requirements	Medium	Medium	High	M, H, H
Aviation Infrastructure	Medium	Medium	Medium	?? 9/11
PC-based Operating Environments	Medium	Medium	Medium	M, H, H
Demand for Newer, Different Data	Low	Medium	Medium	M, M, H



3/19/2002

*Frost & Sullivan 2001



Part II 22



Analysis of Aerial Market Restraints*

Restraints	Impact			
	Near Term (1-2 yrs.)	Mid Term (3-4 yrs.)	Far Term (5-7 yrs.)	Analysis
<i>Cost of Customized Data</i>	High	High	High	H, H, M
Data Markets Fragmented	High	High	Medium	M, H, H
“Free” USG Mapping Data	Medium	Medium	Medium	H, H, M
<i>Education of User</i>	Medium	Medium	Medium	H, H, M
Time to Deliver Customized Data	Medium	Medium	Low	?? 9/11
Profitability of Emergent Market Unproven	Medium	Low	Low	M, H, H
<i>Correctly Anticipating User Needs</i>	Medium	Low	Low	M, M, H
<i>Slow Growth of Non-USG Users</i>	Medium	Medium	Low	M, L, L
Current Planning Timelines for End-User Adoption Unrealistic	Medium	Medium	Low	Agree
Competition From Space Imagery	Low	Medium	Medium	L, L, M





Market Segments

Agriculture

Civil Government

Entertainment/Media

Environmental

Exploration & Mining

Forestry

Insurance

Mapping

Military/Intelligence
(National/Global Security)

Real Estate

Telecommunications

Transportation

Utilities



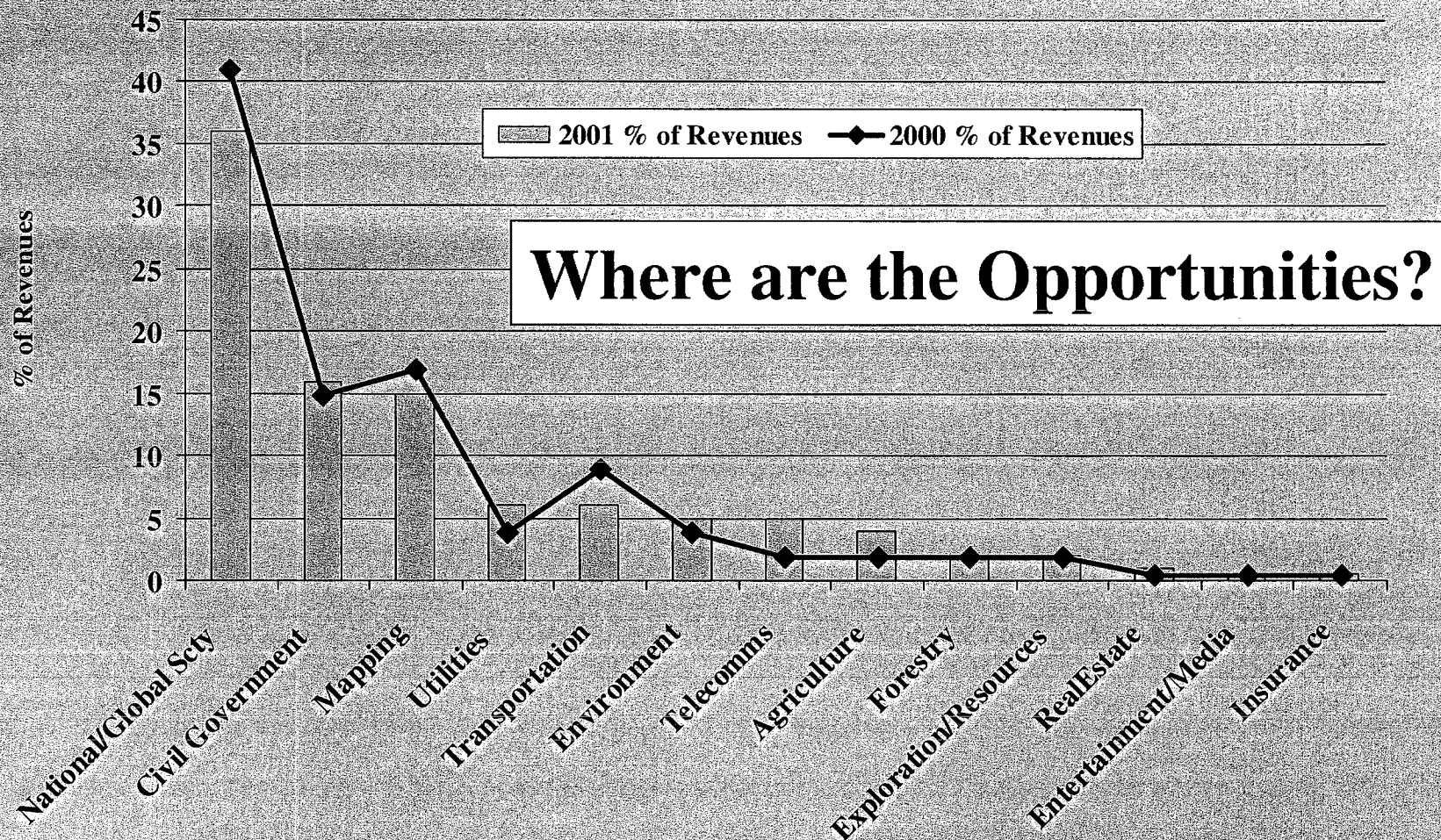
3/19/2002



Part II 24



% of Revenues by Market Segment 2000 & 2001



Based on Responses of >40 CEOs/CFOs
(nearly 20% of "Core Companies")



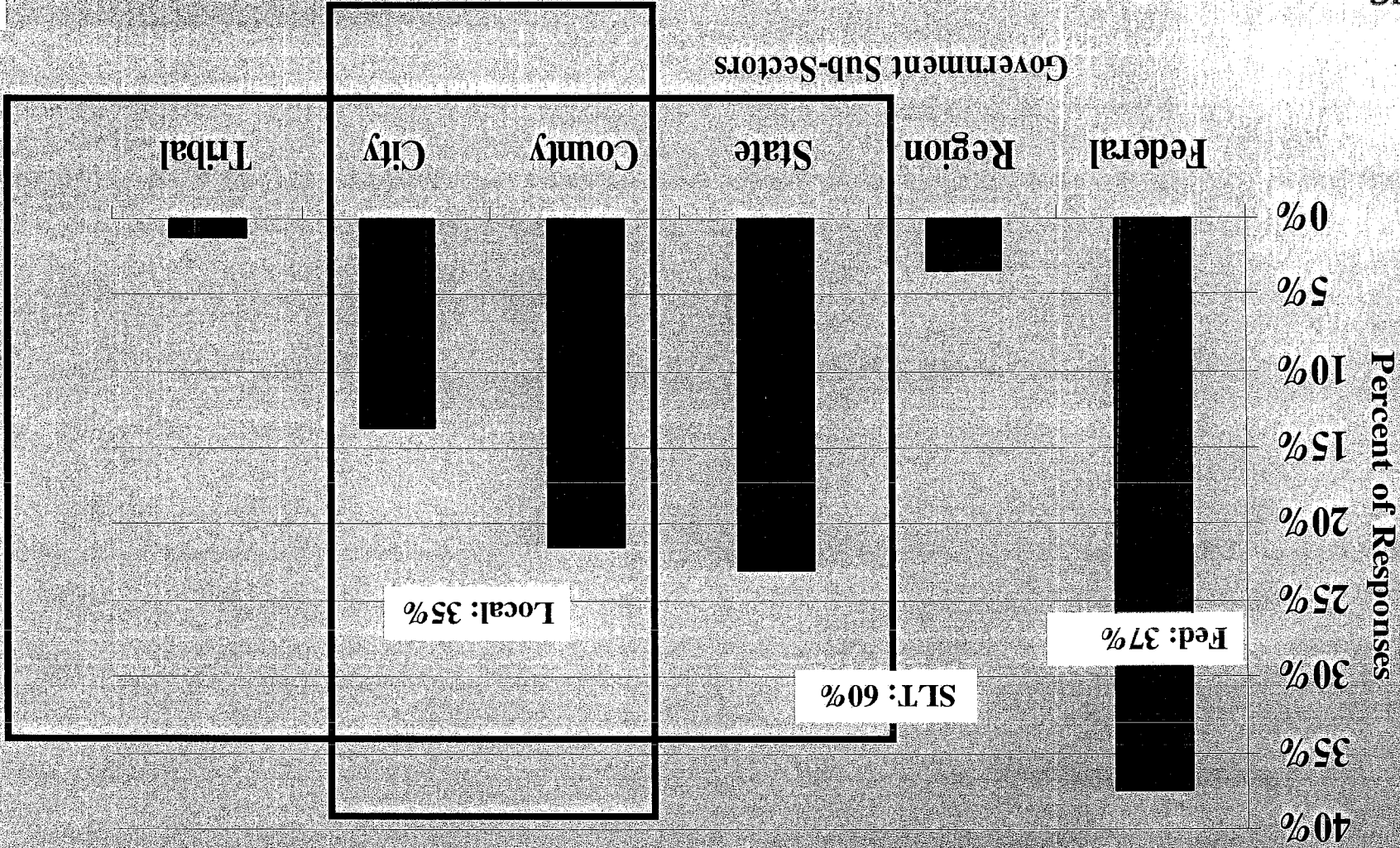
3/19/2002



Part II 25



Government Sub-Sectors of Employment



Based on Phase II 344 Survey Responses: Federal 128, State 79, County 74, City 47, Regional 12, Tribal 4





The County* GIS/RS “Environment”



(A Major Potential Customer Group)

- ✓ While not fully aware of the terminology and capabilities of a GIS, most NACo (elected officials) interviewees know it is related to mapping
- ✓ 1998 NACo GIS committee established to educate the NACo membership
- ✓ Current users of GIS are strong advocates
- ✓ Generally, county government GIS databases have a wide range of maturity
 - County capabilities vary from computerless to hi-tech
 - Usually combine aerial photography with existing GIS
- ✓ The contact person at the county level is the GIS Coordinator. This is where the GIS knowledge lies.
 - Resides in various departments, e.g., Planning, Information Technology, County Assessors, County Surveyors, etc.
- ✓ Elected officials must address political as well as GIS issues when making decisions



Based on Phase I Survey Responses

3/19/2002

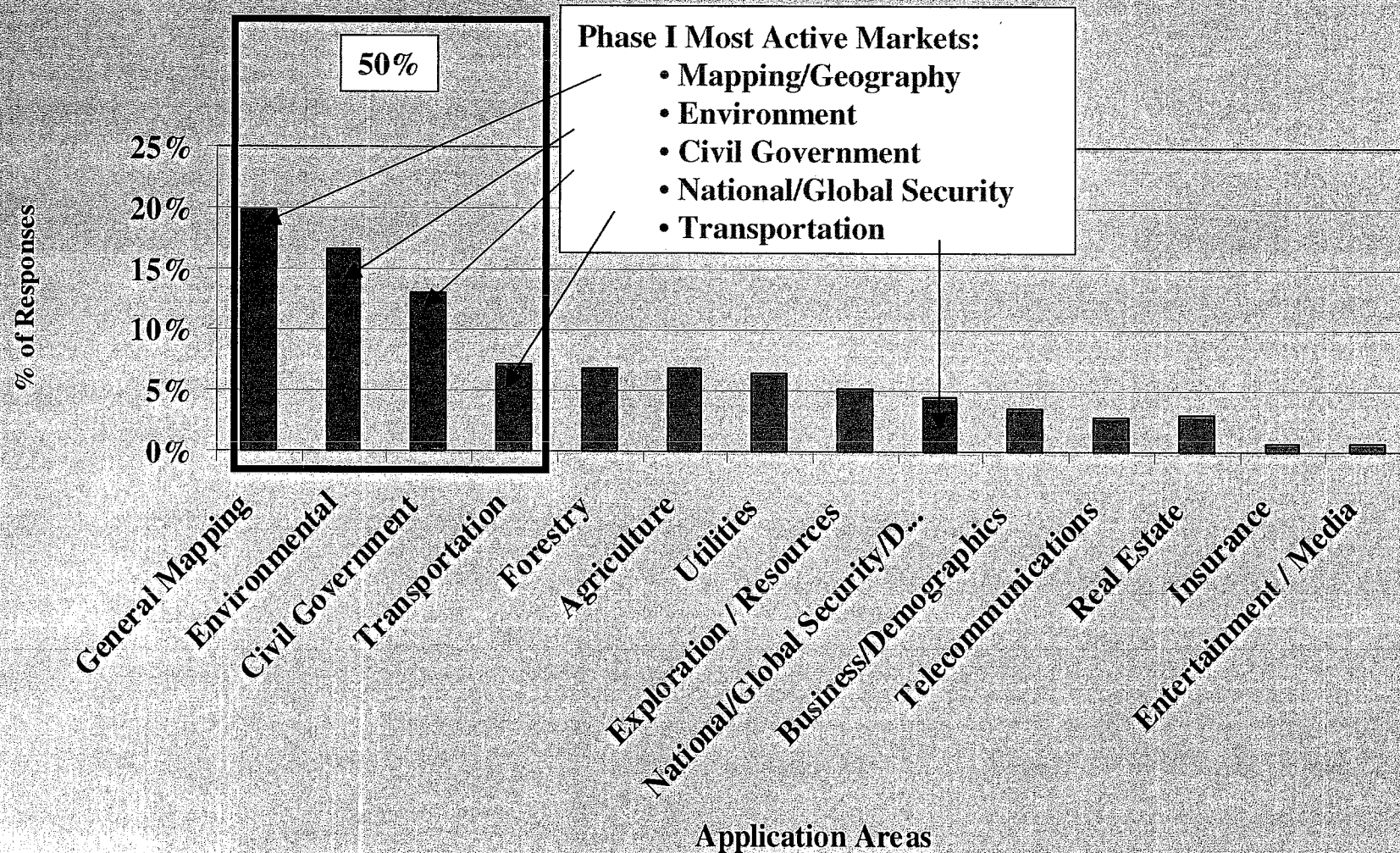
* Per 51 NACo Interviews



Part II 27



Application Areas In Which Respondents Work



Based on Phase II 2440 Survey Responses

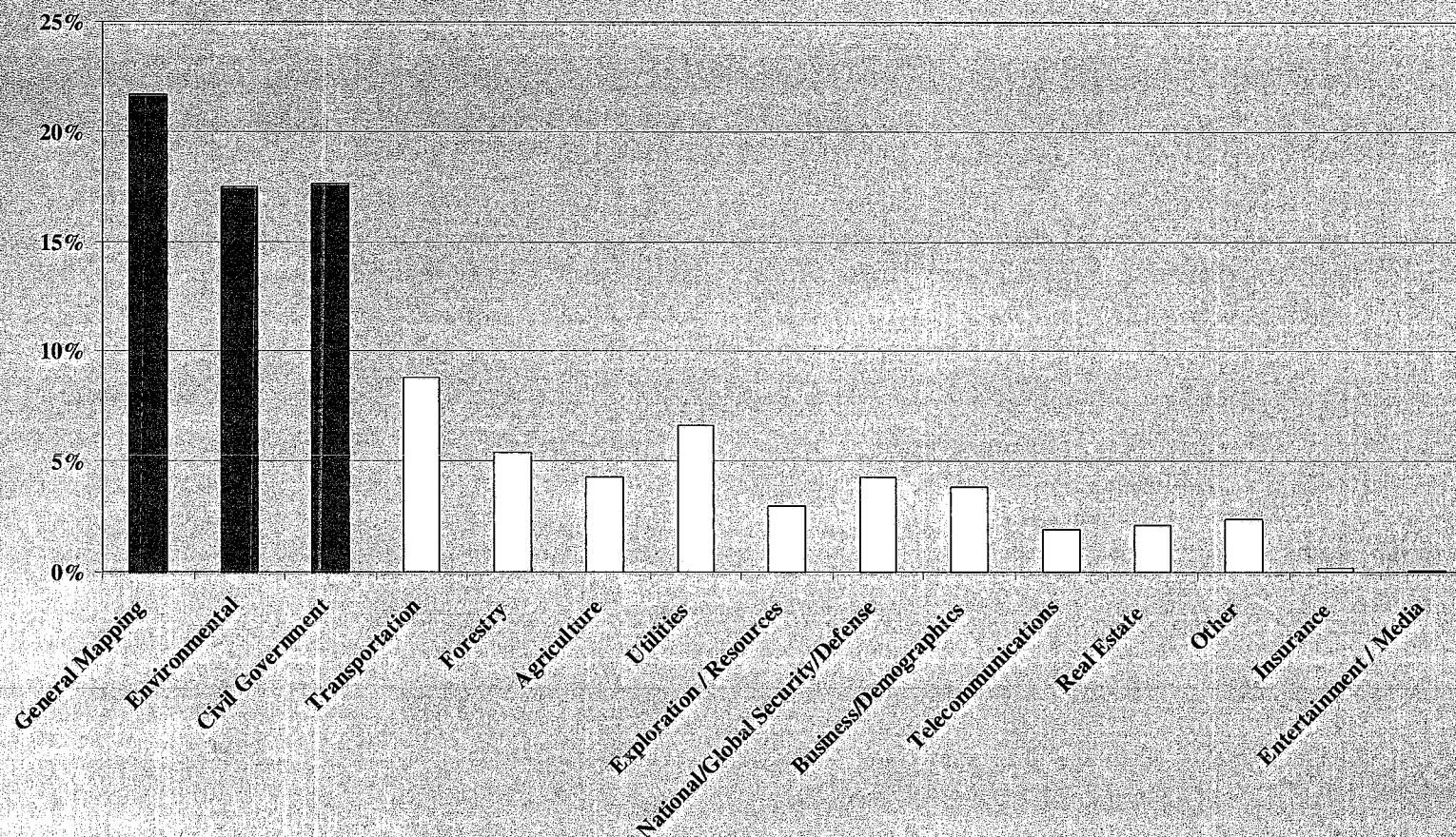
3/19/2002



Part II 28



Application Areas In Which Government Respondents Work



About 55% of the Government Sector workforce is involved in General Mapping, Environment, Civil Government Application Areas.



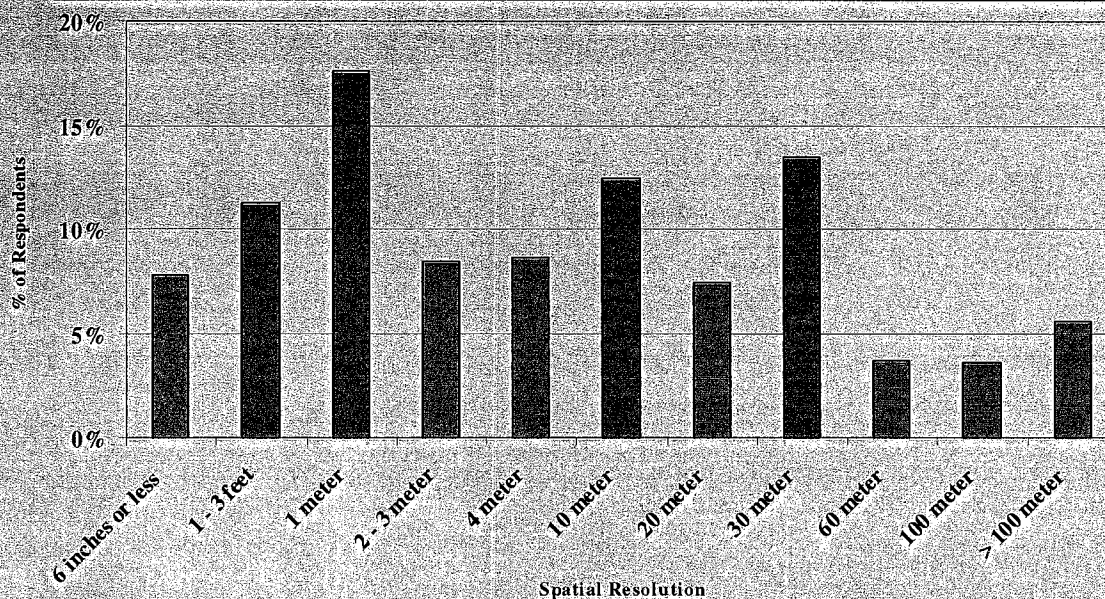


- ✓ **Spatial Resolution**
- ✓ **Geo-location Accuracy**
- ✓ **Data Layers**
- ✓ **Elevation Accuracy**
- ✓ **Image Types**
- ✓ **Area Coverage**
- ✓ **Timeliness**

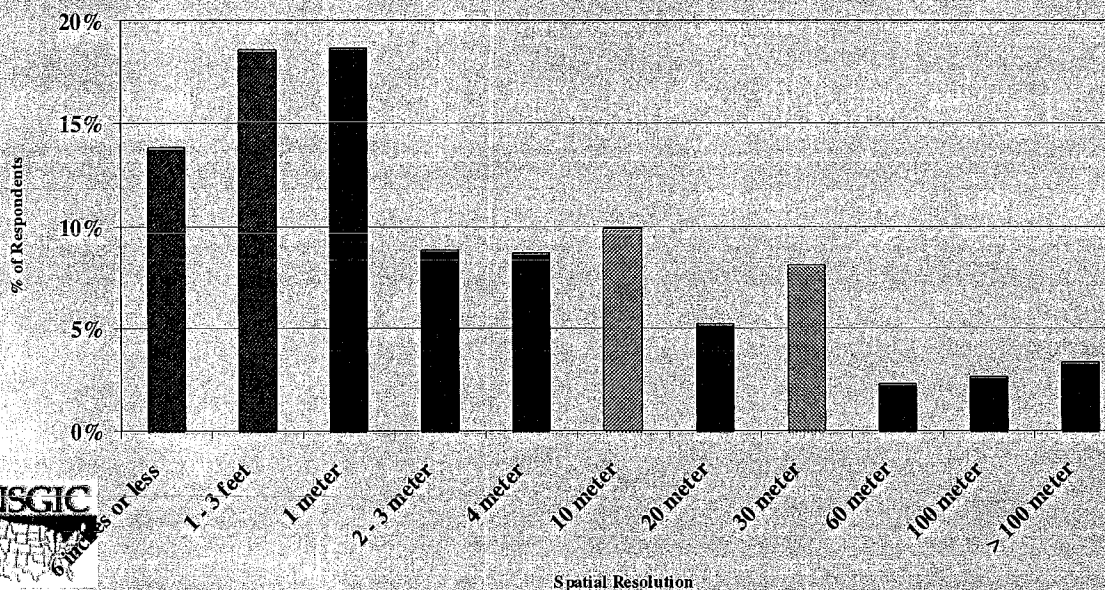




Spatial Resolution: Use vs. Need (All Sectors)



Currently, 1 foot to 1 meter; 10 meter; and 30 meter spatial resolutions are the most used



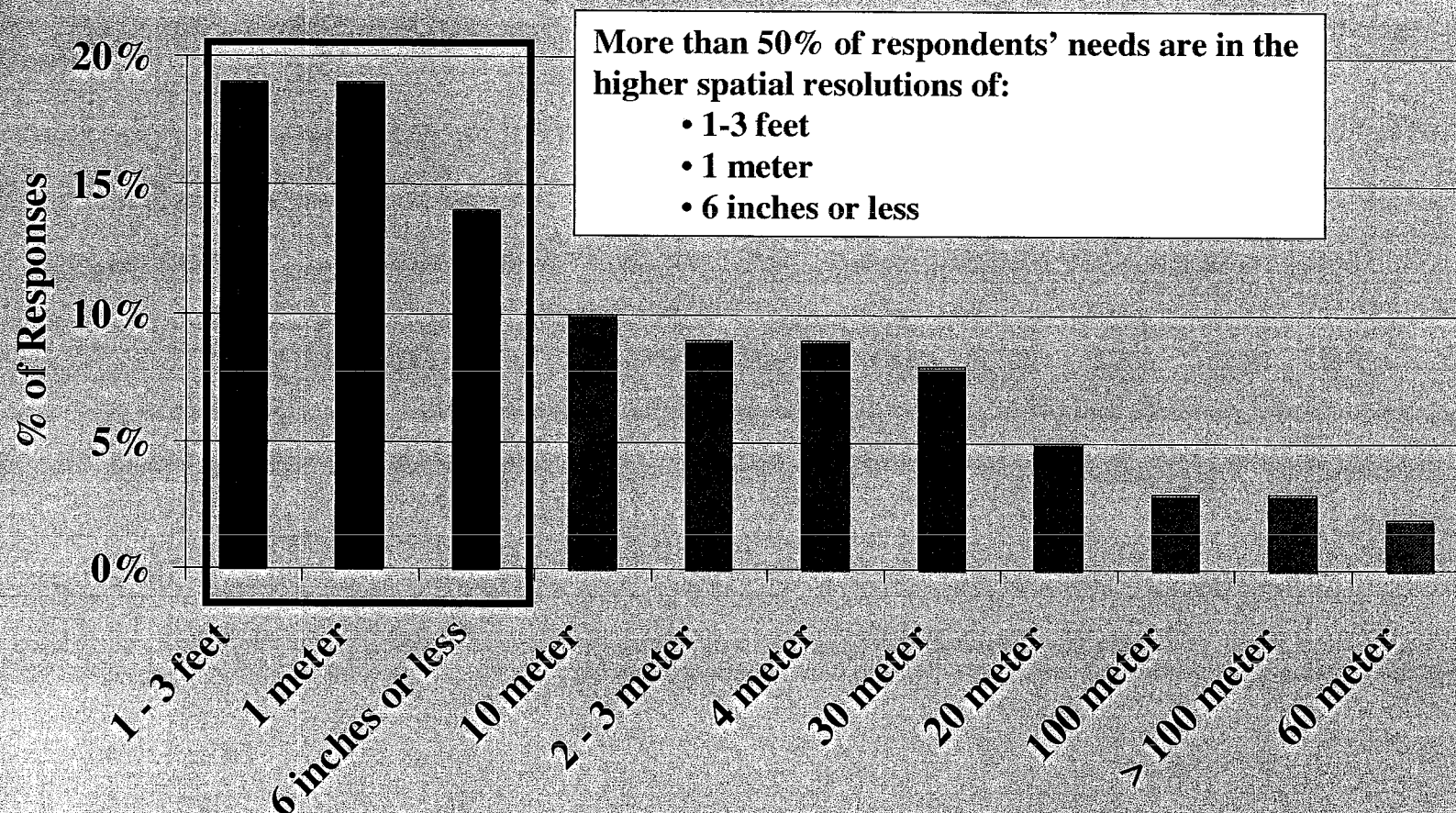
There is a definite shift toward higher spatial resolution, especially to meet needs at the 3-foot and less levels





Spatial Resolution Need (All Sectors)

Rank Ordered by % of Responses



Spatial Resolutions



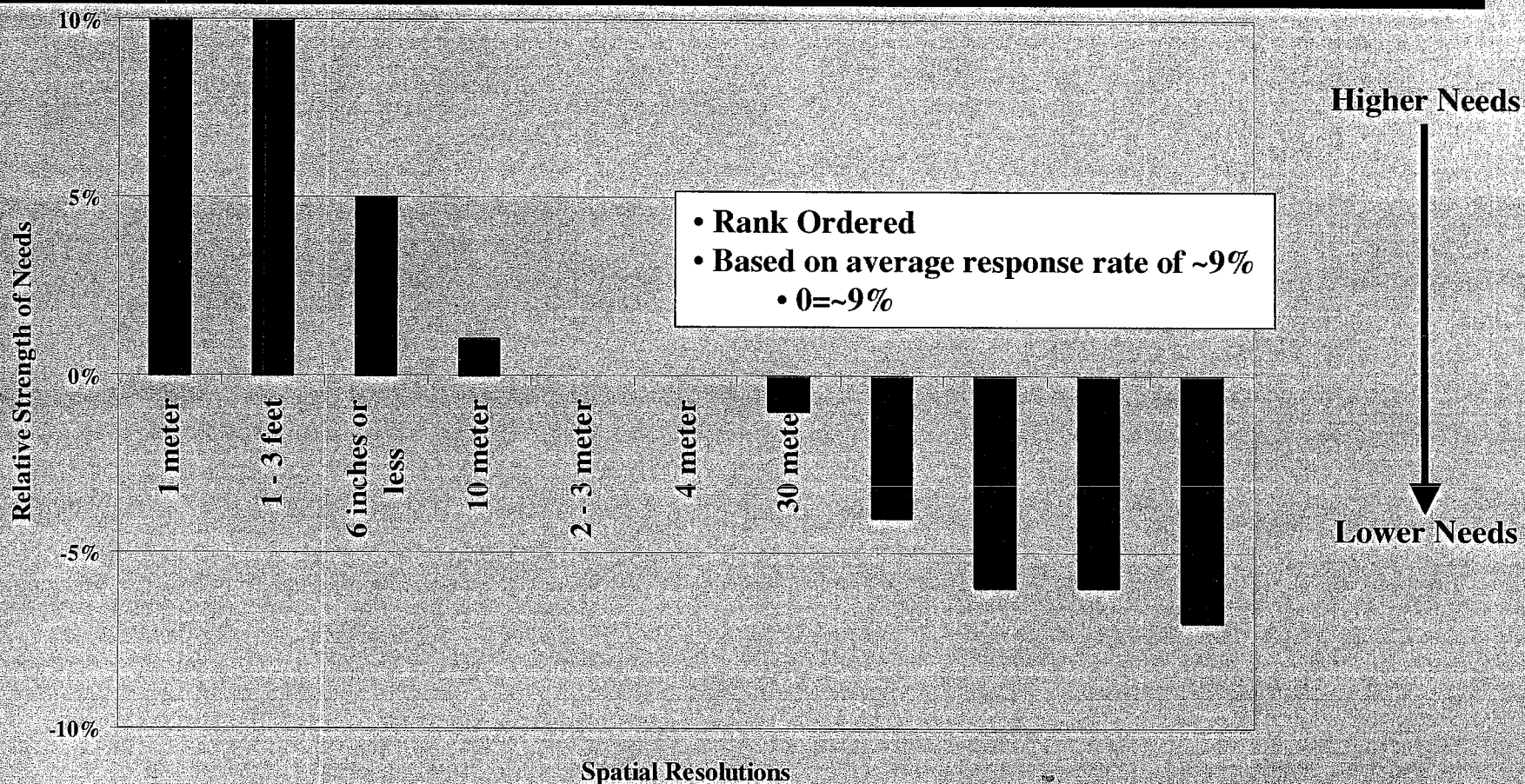
3/19/2002



Part II 32



Relative Spatial Resolution Needs (All Sectors)

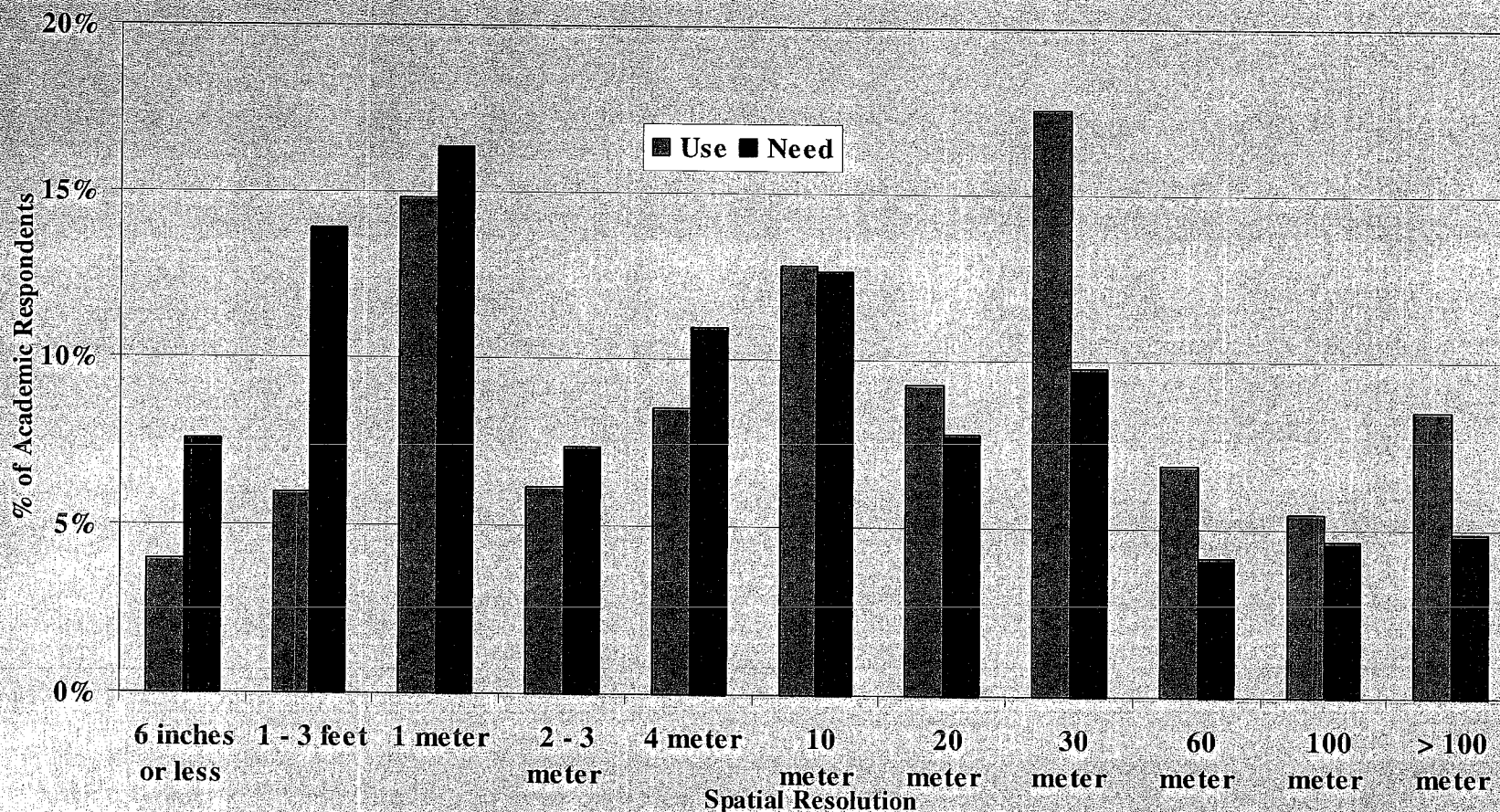


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Spatial Resolution Use Vs. Needs : Academic



The Academic Sector shows fairly strong needs in the 1-3 feet and 6 inches or less resolutions and a lesser needs at 30 meters and less levels

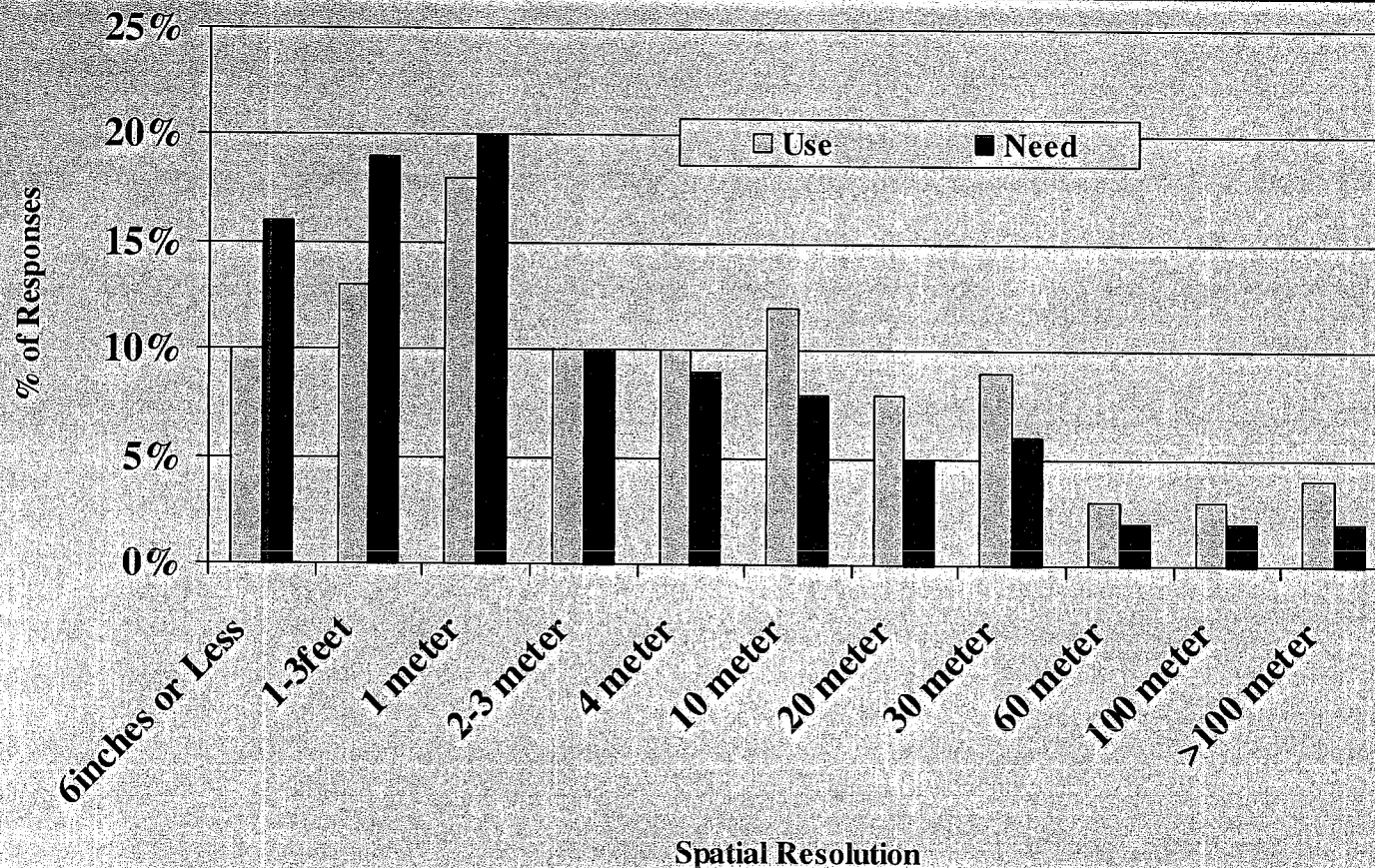


3/19/2002





Spatial Resolution Use Vs. Needs : Commercial



Commercial use and needs tend toward higher resolutions (especially 1 meter and higher), probably due to less price sensitivity than Government or Academic Sectors



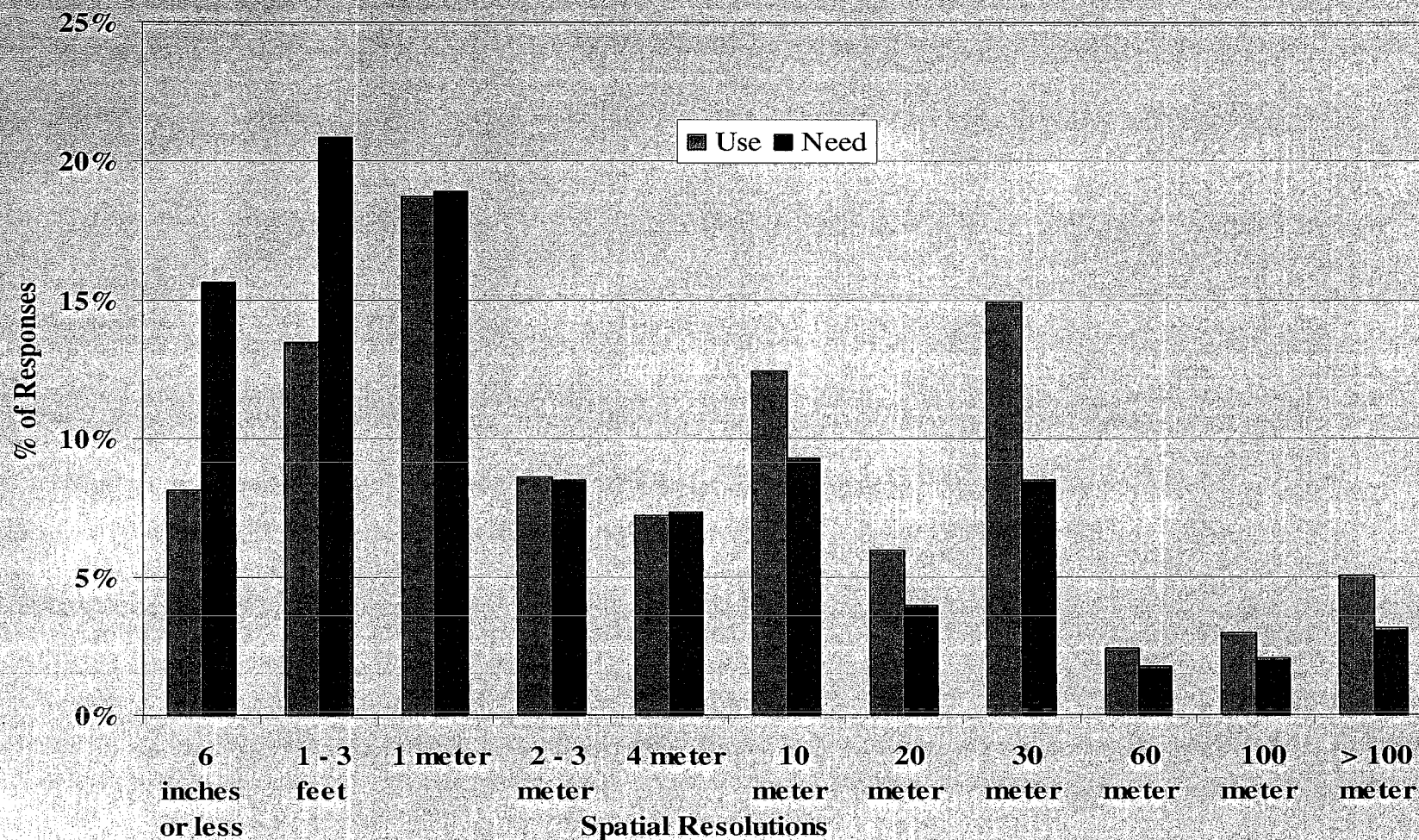
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Part II 35



Spatial Resolution Use Vs. Needs: Government



Government needs are shifting to the higher spatial resolutions



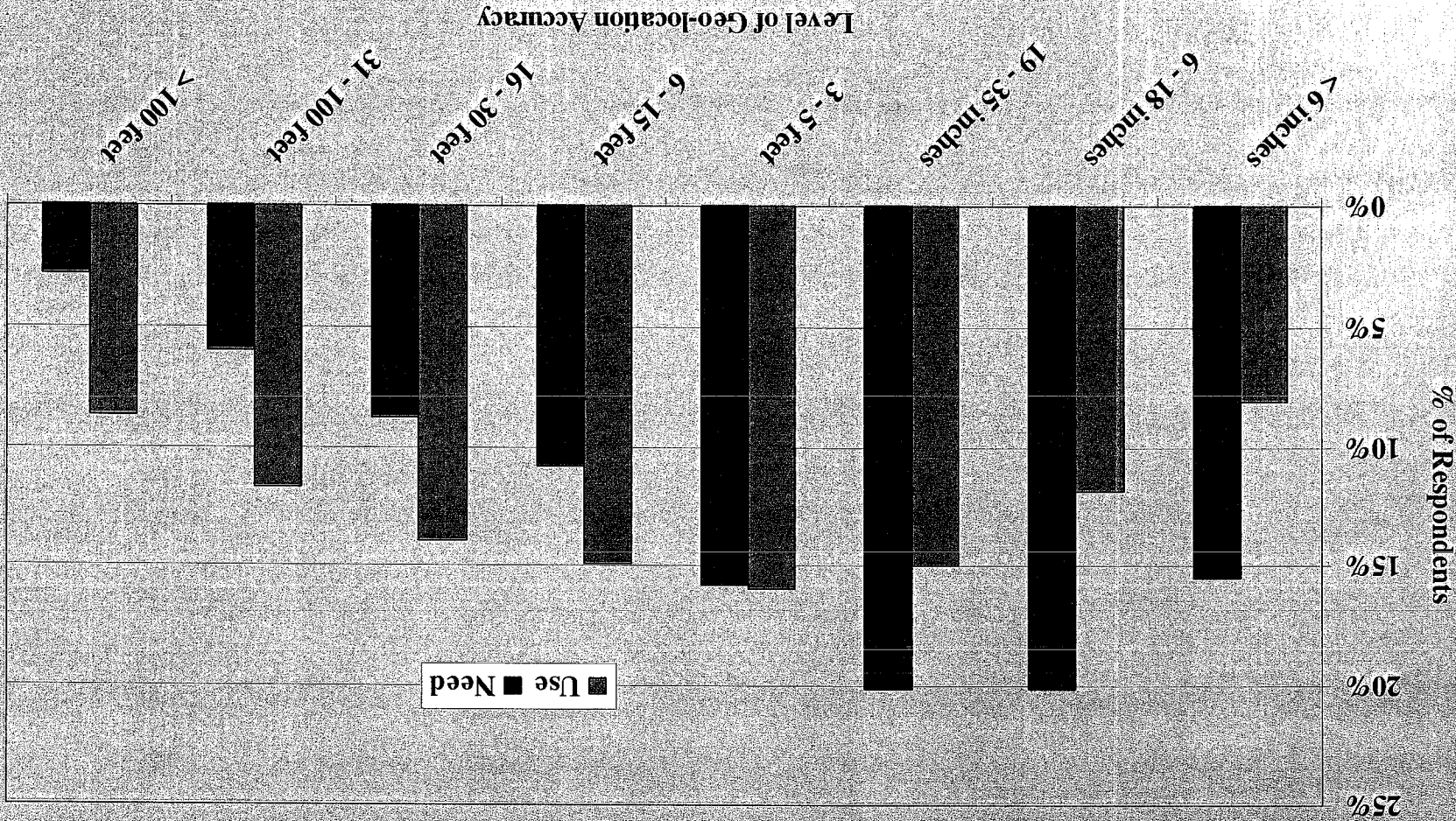
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Part II 36



• There is a mismatch between Geo-location accuracies in Use vs. Needs

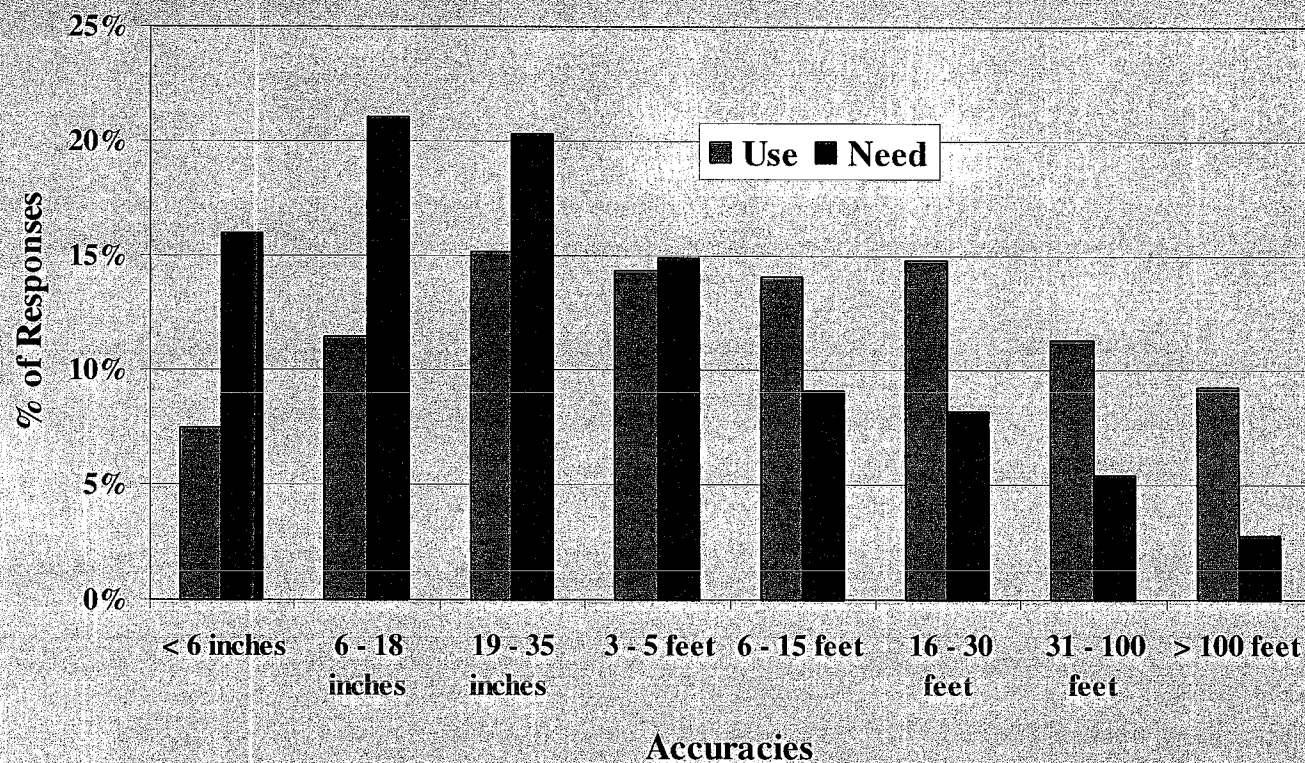


Geo-location Accuracy Use Vs. Needs: All Sectors





Geo-location Accuracy: Government



The Government Sector has pronounced needs for Geo-location accuracies at levels less than 3 feet



Responses: 647 Use; 537 Need

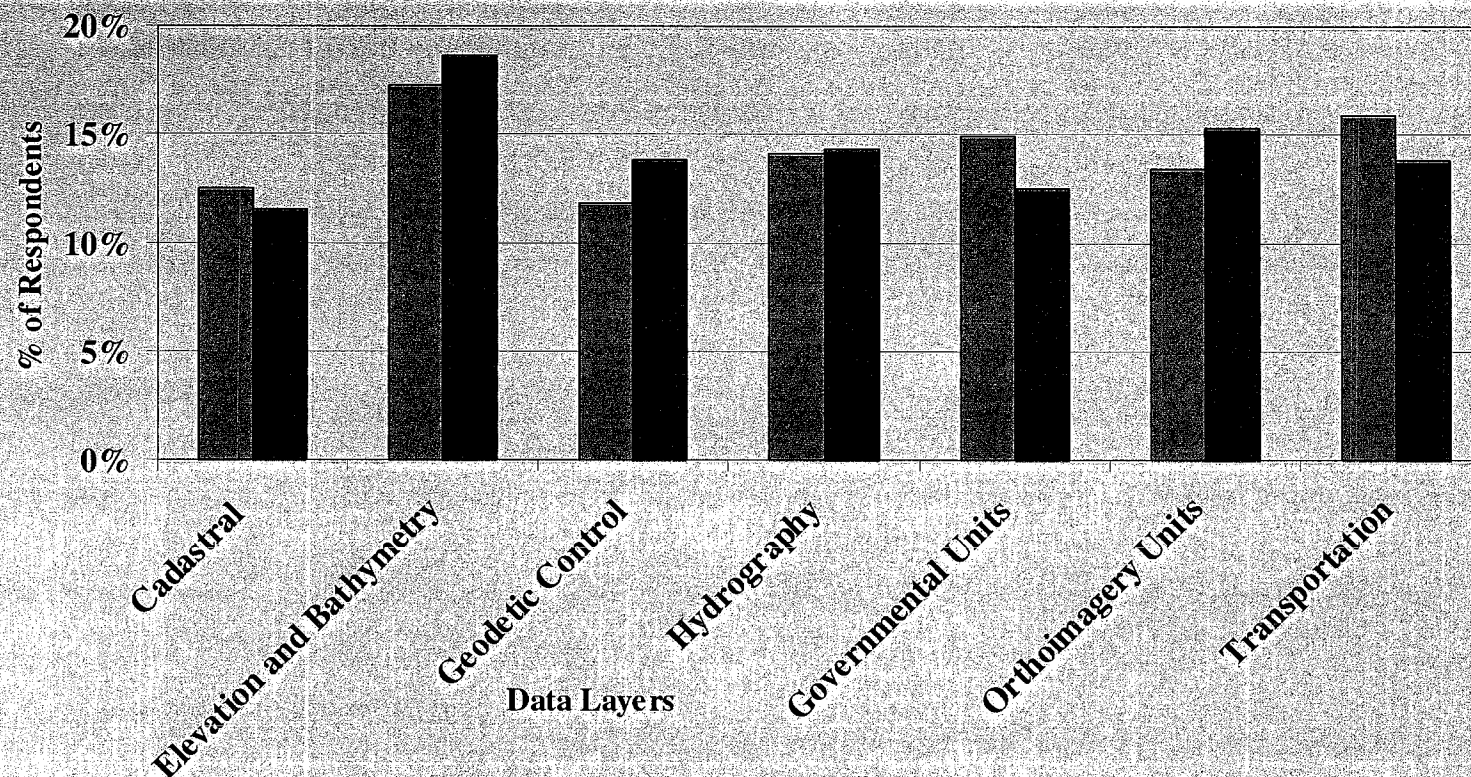
3/19/2002



Part II 38



Data Layers: Use Vs. Need All Sectors

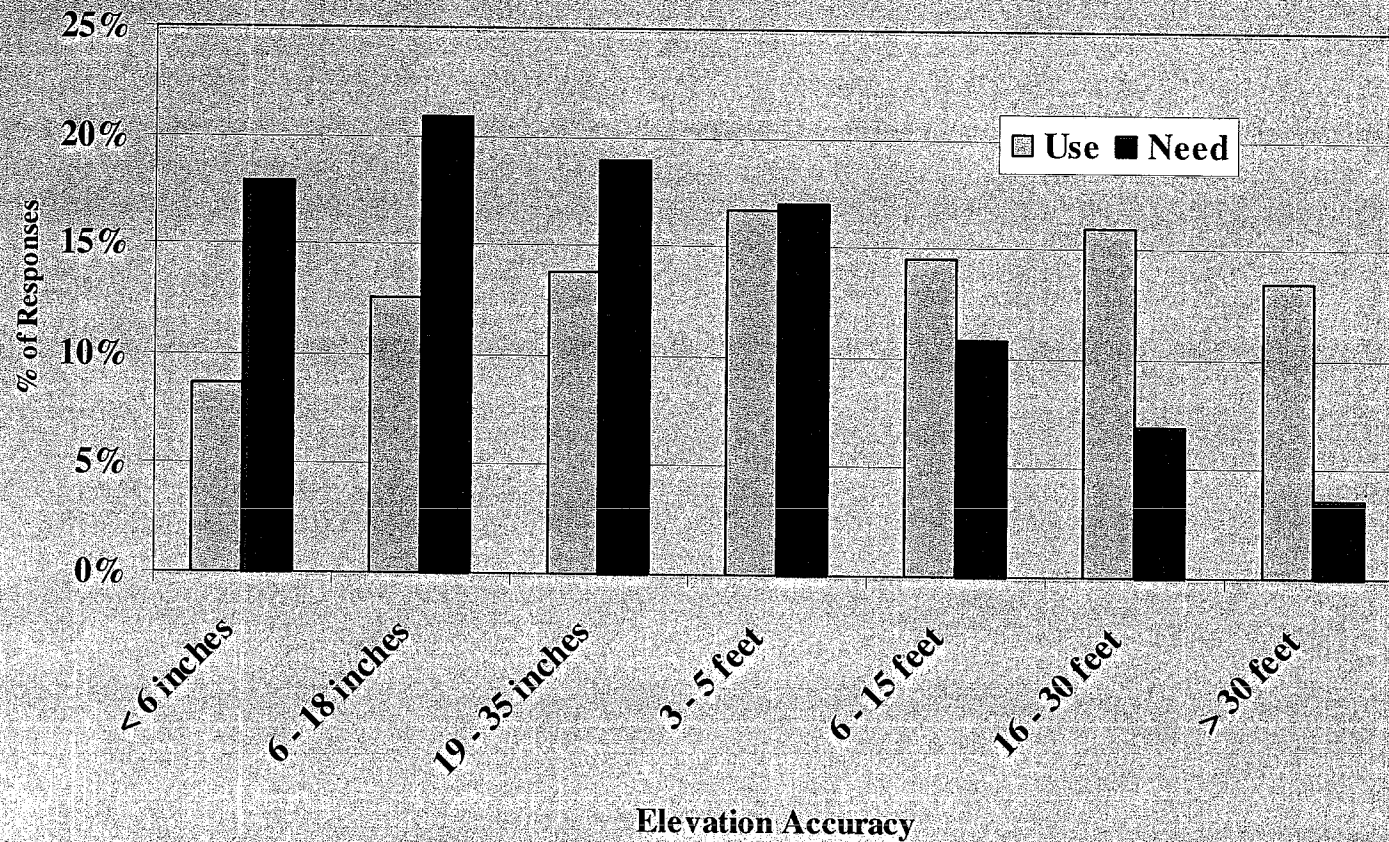


- Sectors tend to use and need the data layers in similar proportions
- Elevation/Bathymetry and Orthoimagery Units are most used and most needed
- Cadastral is least used and needed





Elevation Accuracy: Use vs. Need (All Sectors)

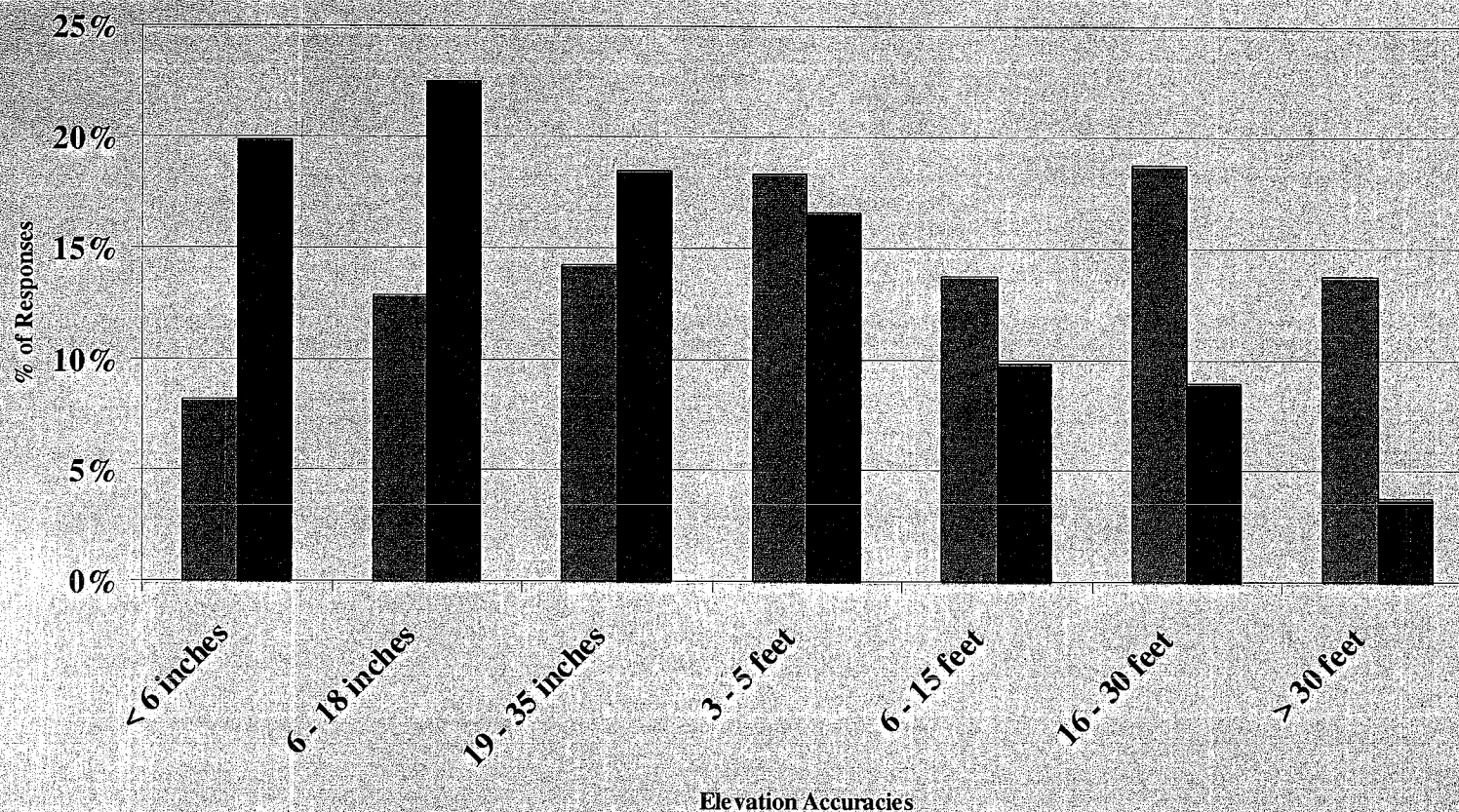


- There is a major mismatch in elevation accuracies in Use vs. Needs
- About 60% of the need is at elevation accuracies of less than 3 feet





Elevation Accuracy Use vs. Need: Government Sector



A large gap between what is being used vs. what is needed occurs in the 18 inches and less regimes



Responses: 467 Use; 445 Need

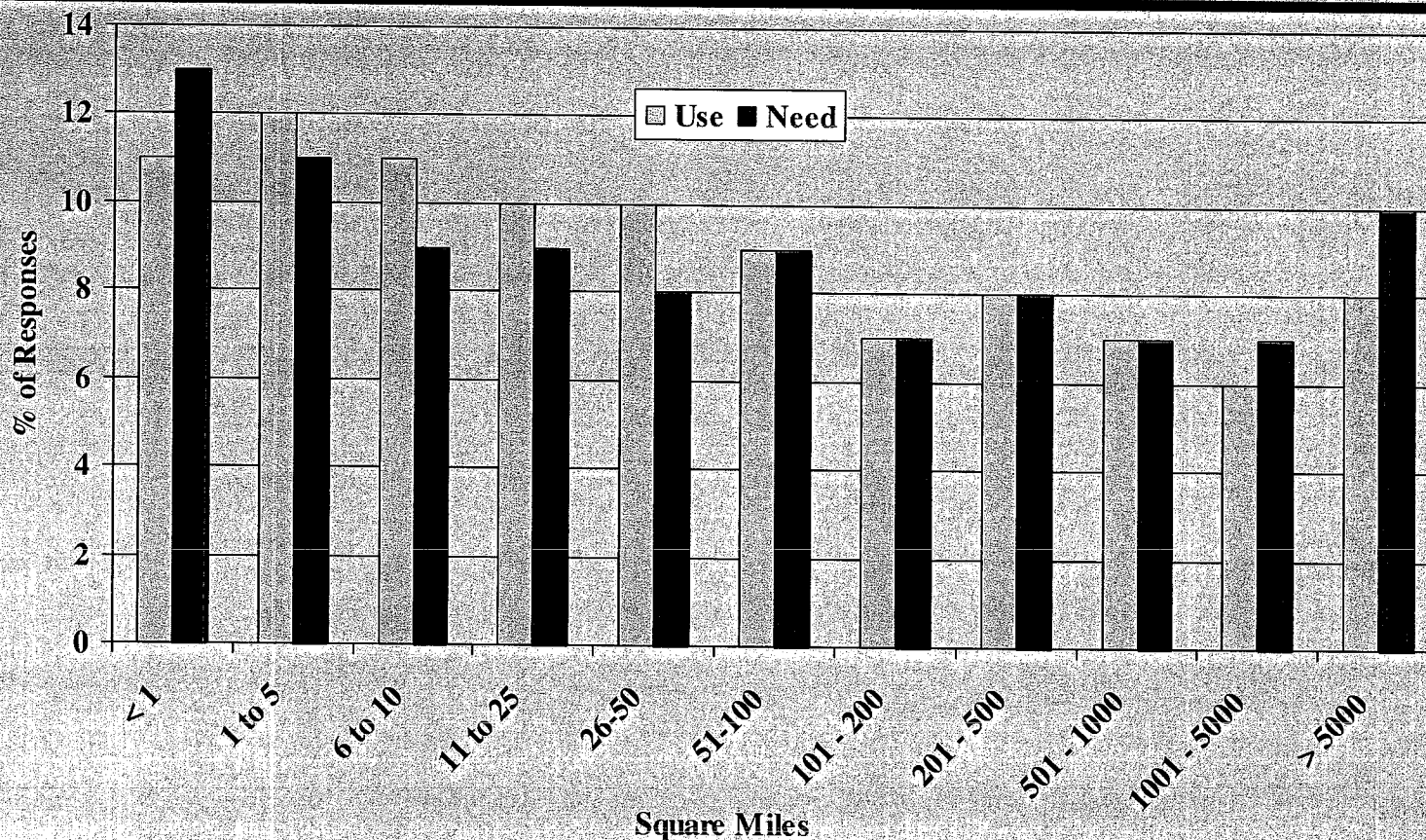
3/19/2002



Part II 41



Area Coverage: Use versus Need (All Sectors)



- Area Coverage use and needs are fairly well aligned
- There appear to be some unmet needs at the extremes (<1 Sq. Mi. and >5000 Sq. Mi.)



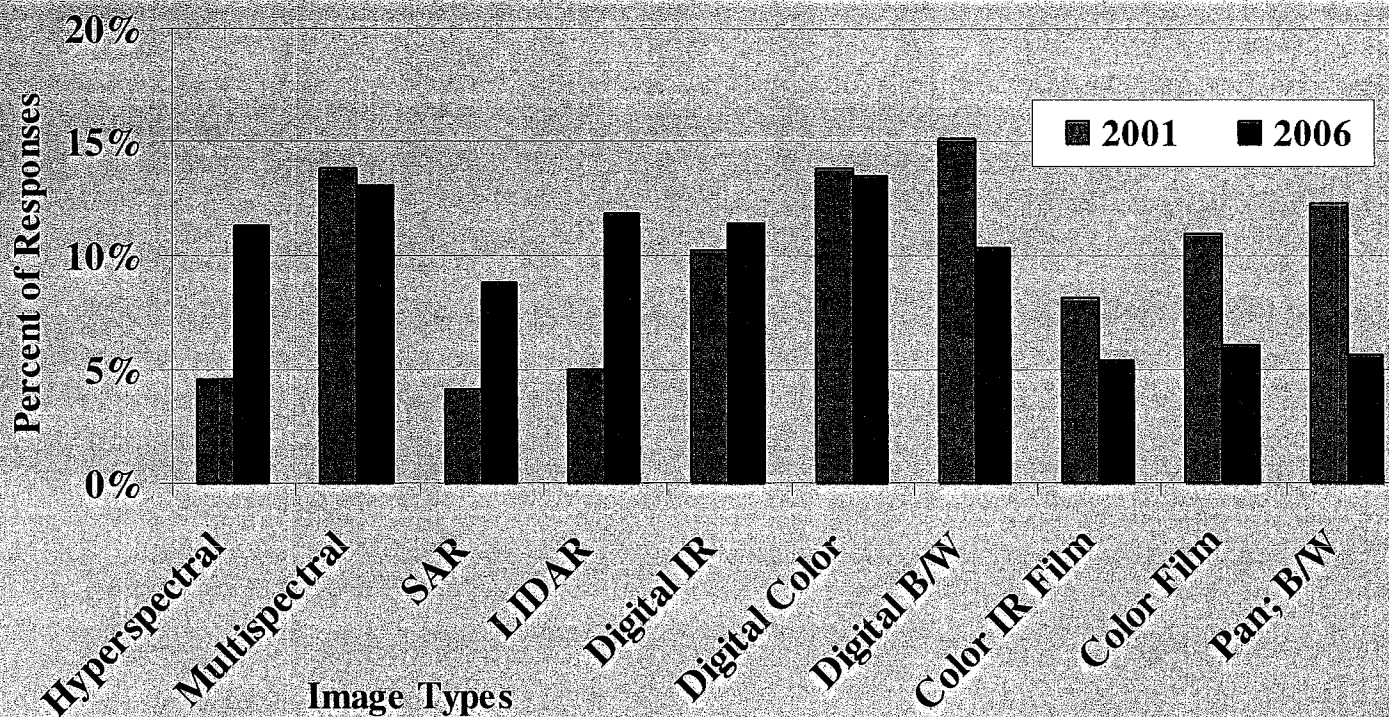
3/19/2002



Part II 42



Use of Image Types: 2001 vs. 2006 (All Sectors)



Most used in 2001 (>10%)

1. Digital B/W
2. Multispectral
3. Digital Color
4. Pan Film (Pan; B/W)
5. Color Film
6. Digital IR

Most in use in 2006 (>10%)

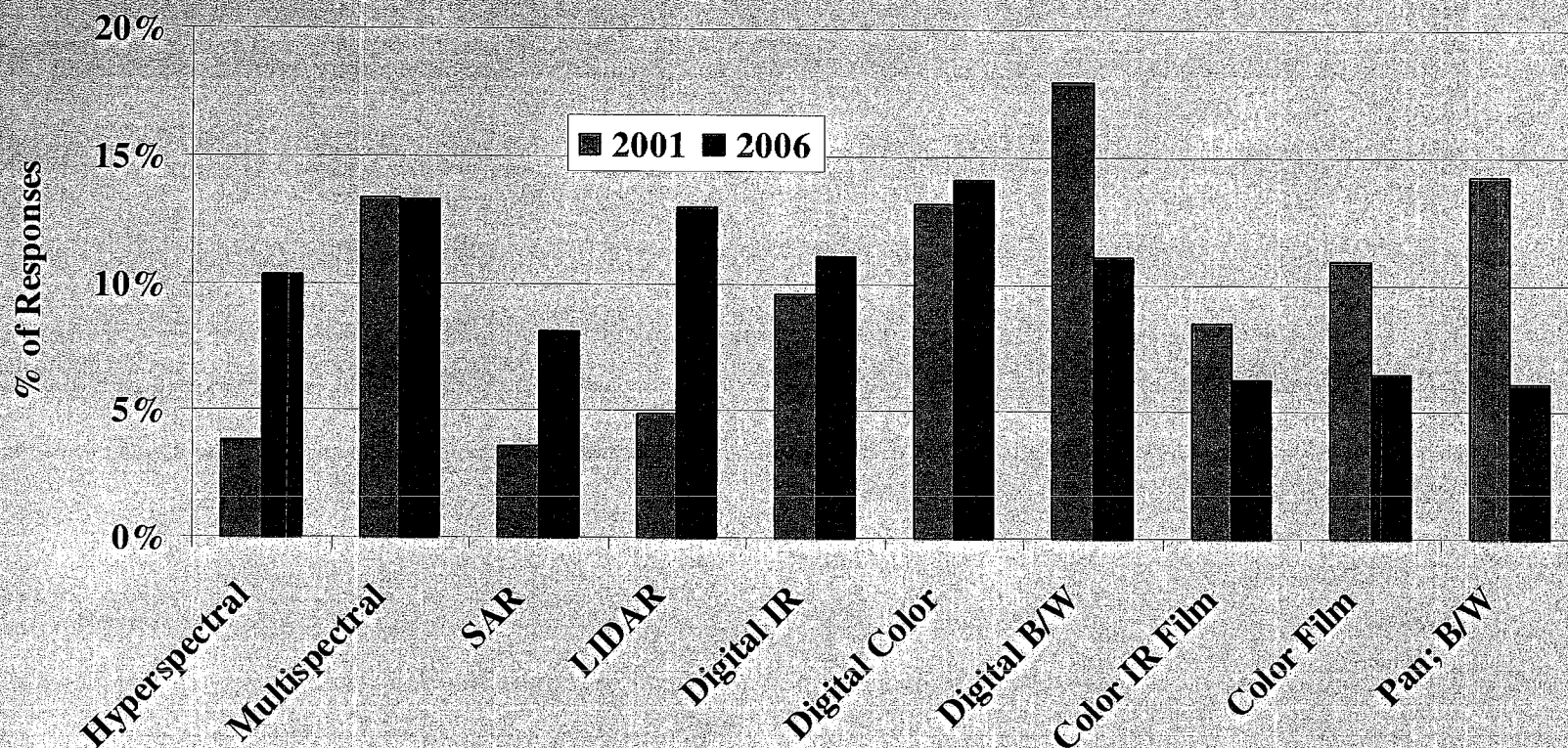
1. Multispectral
2. Digital Color
3. LIDAR
4. Digital IR
5. Digital B/W
6. Hyperspectral

We believe "Digital" includes digital capture and analog scanned products





Use of Image Types 2001 vs. 2006: Government Sector



- Biggest increases: Hyperspectral, SAR, and LIDAR
- Biggest decreases: Pan B/W; Color Film; Color IR Film; Digital B/W



Responses: 1124 (2001) 1231 (2006)

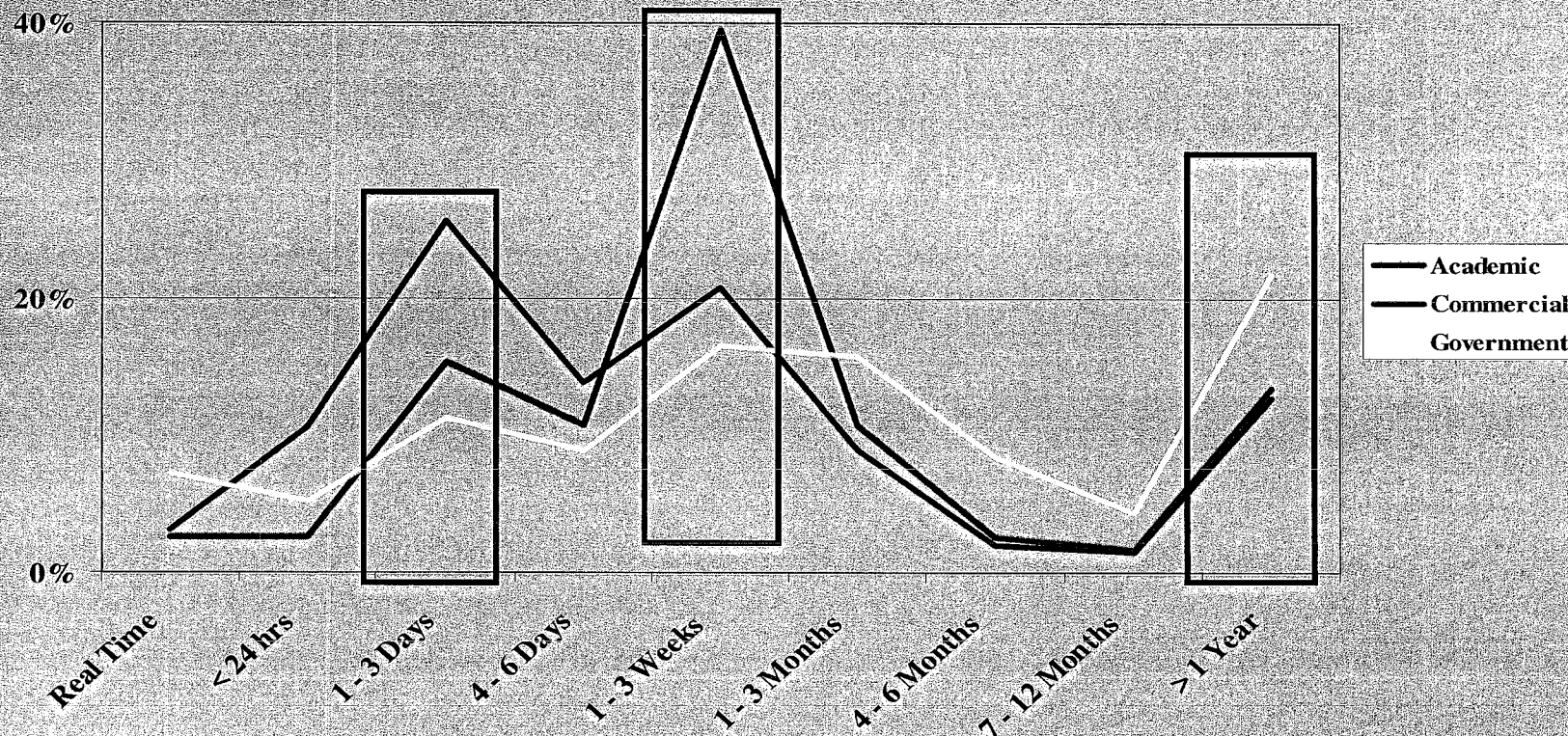
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Part II 44



Timeliness Requirements

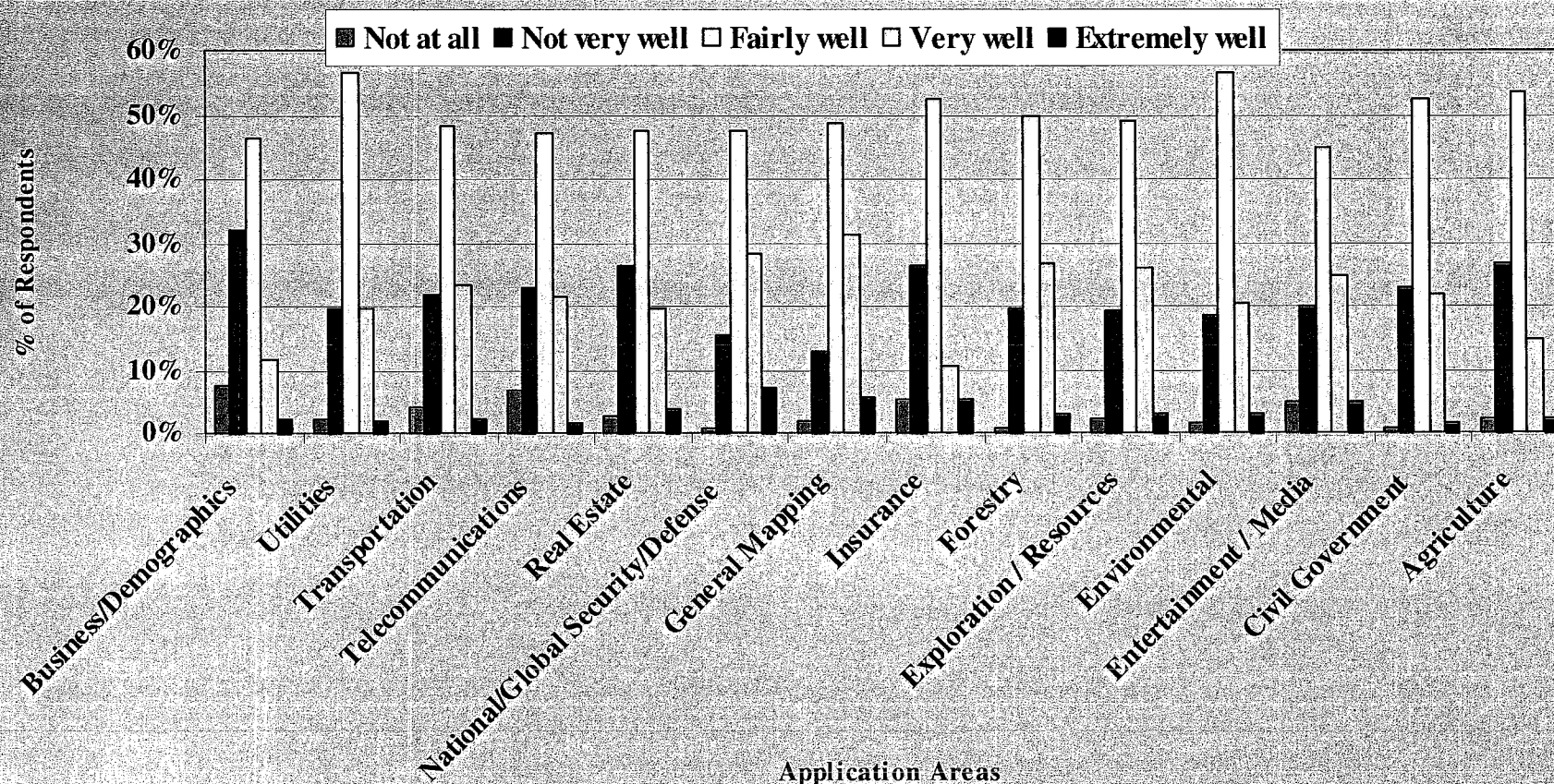


- Government Sector has more interest in “Real Time” range than other Sectors
- Nearly 60% of Commercial Sector interest centers on the “1-3 Days” and “1-3 Weeks” ranges
- All Sectors show high interest in the “1-3 Weeks” range
- Timeliness requirements mirror from sector to sector and cluster around the “1 – 3 Day”; “1-3 Week”.
- For a large % of the Government Sector timeliness is not an issue





All Sectors – How well are your needs being met by Application Area?

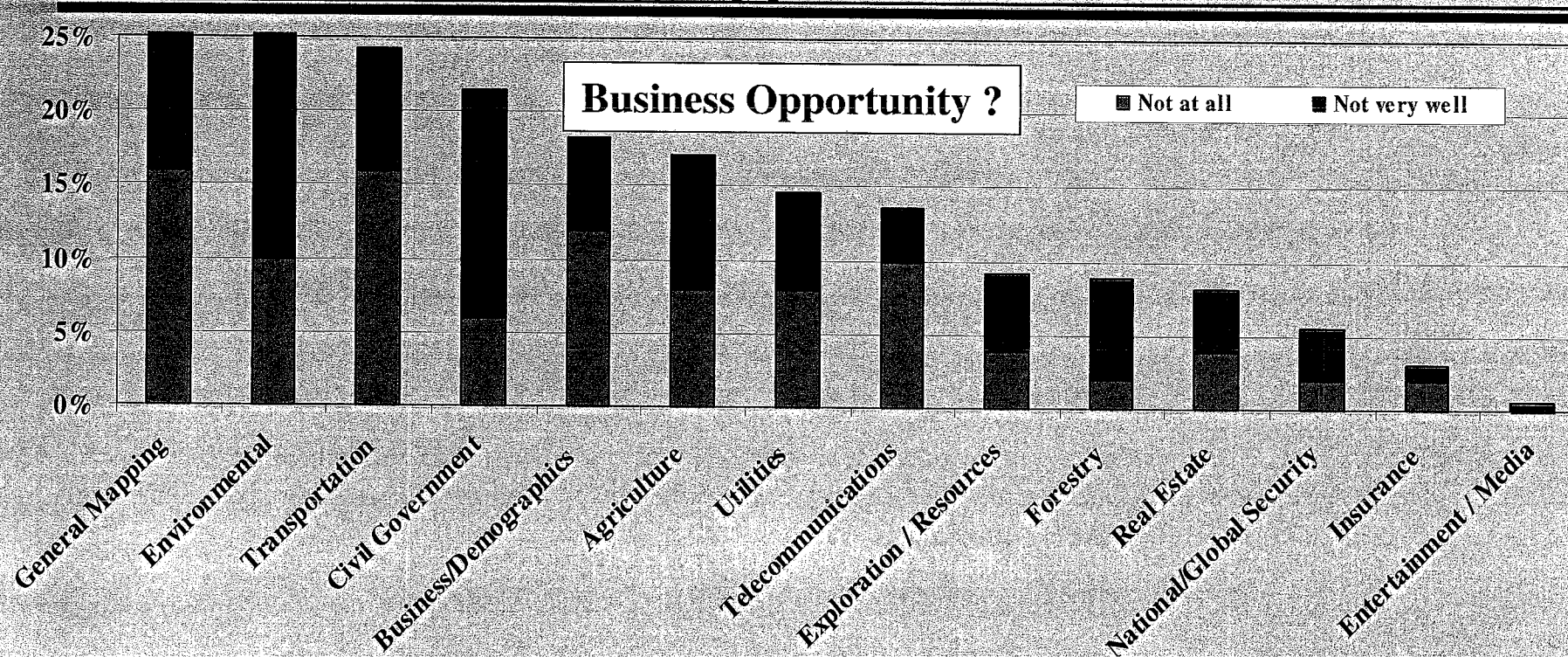


- The majority of needs are met “fairly well” or better
- Approximately 25% are met “not very well” or “not at all”
 - A potential business development opportunity to grow from “fairly” to “very-extremely well”





How well are your needs being met in the following Application Areas?



Phase I Most Active Markets

- General Mapping
- Environmental
- Civil Government
- National/Global Security
- Transportation

Phase II Where Most People Work

- Mapping & Geography
- Environmental
- Civil Government
- Transportation

CEO/CFO Most Revenue

- National/Global Security
- Mapping
- Civil Government
- Transportation
- Environmental
- Utilities



3/19/2002

Based on Phase II 2422 Survey Responses: Not at all 50, Not very well 482, Fairly well 1239, Very well 569, Extremely well 82



Part II 47



Importance of DIS Characteristics



Interview

Characteristics	Important	Most Important
Geo-Location Accuracy	76	41
Spatial Resolution	76	40
Cost	34	4
Currentness/Timeliness of Data Delivery	27	7
Color/Spectral/Radiometric Quality	23	9
Ease of Use	23	
Software Utility Compatibility	18	1
Data Format	16	
Area Coverage/Theme Size	15	1

- ✓ Spatial Resolution and Geo-location Accuracy are the most important characteristics
- ✓ Cost is an important characteristic but not most important to this *interview sample*. ... **HOWEVER**, *survey sample* indicates that cost is a major driver for purchasers of data/information

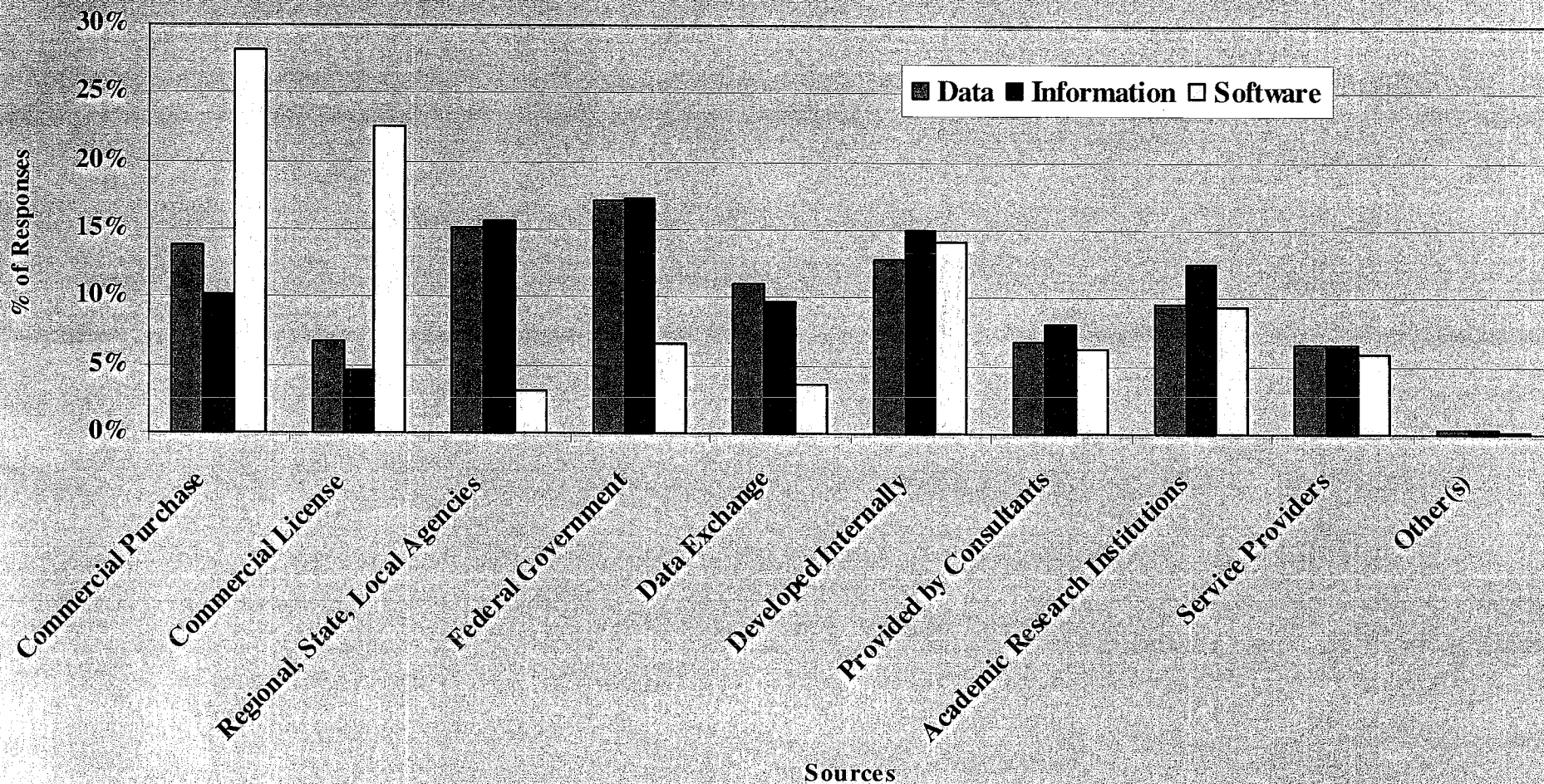
Survey

	More Important	Less Important
Academic	<ul style="list-style-type: none"> •Spatial Resolution •Cost •Color & Quality •Currentness •Geo-location Accuracy 	<ul style="list-style-type: none"> •Timeliness •Revisit Rate
Commercial	<ul style="list-style-type: none"> •Geo-location Accuracy •Currentness •Cost •Spatial Resolution •Ease of Use 	<ul style="list-style-type: none"> •Revisit Rate •Documentation
Government	<ul style="list-style-type: none"> •Currentness •Cost •Geo-location Accuracy •Accuracy Statement •Spatial Resolution •Documentation •Area Coverage 	<ul style="list-style-type: none"> •Revisit Rate





% Reliance on Sources of Data, Information, Software (DIS)



Based on Phase II 6382 Survey Responses: Data 2826, Information 2367, Software 1189





DIS Providers

- ✓ Assume following “Provider Groups”
 - Private: Commercial Purchase & License; Consultants; Service Providers
 - Public: Federal; Regional, State, Local, Tribal
 - Academic Research
- ✓ Then, how much DIS product does each “Provider Group” send to the marketplace?

Provider Groups	Products to Marketplace		
	Data	Information	Software
• Private	30 %-35 %	25 %-30 %	60 %-65 %
• Public	30 %-35 %	30 %-35 %	~10 %
• Acad. Research	~10 %	10 %-15 %	5 %-10 %
Totals*	70 %-80 %	65 %-80 %	75 %-85 %

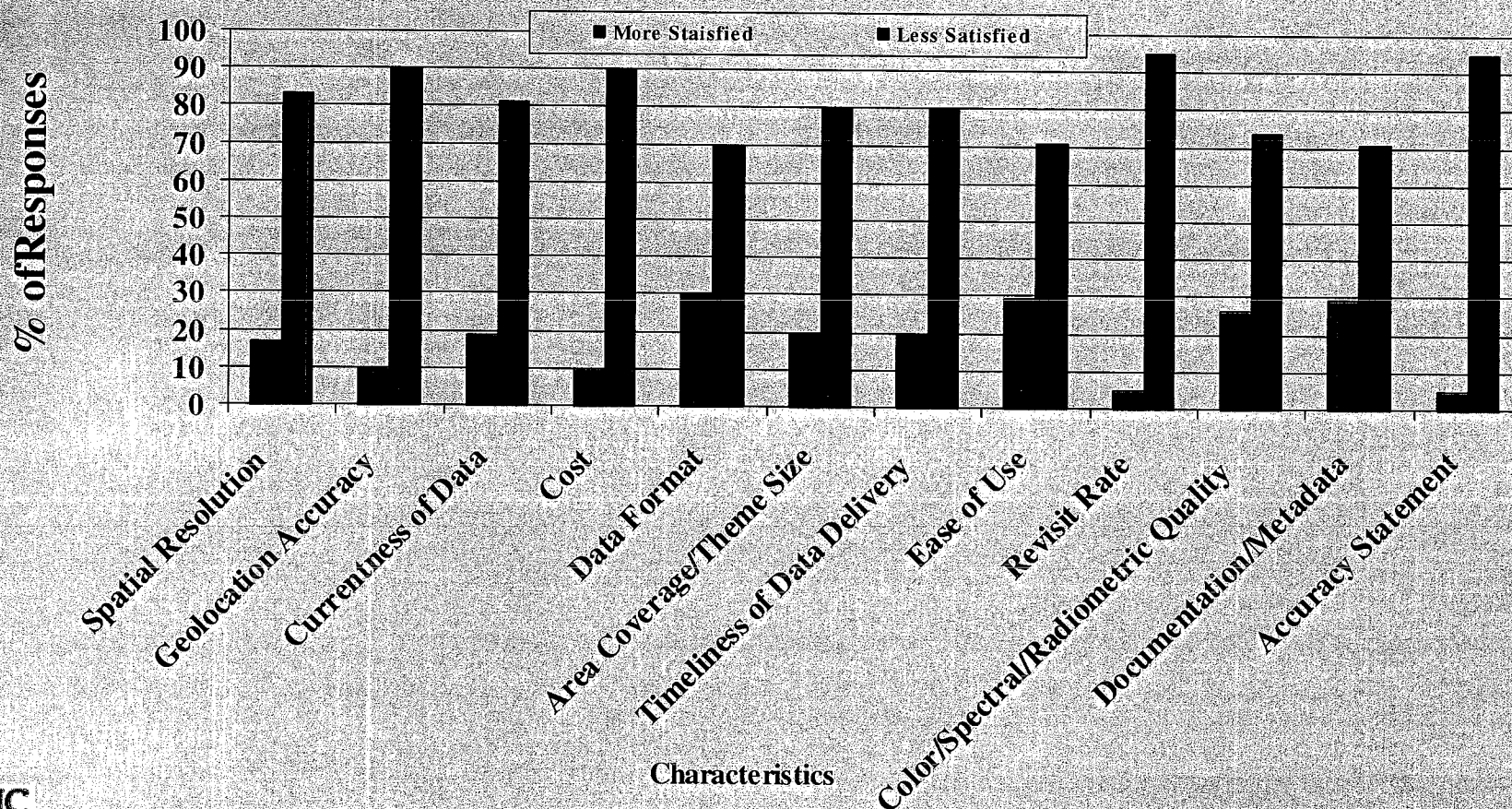
* Other “Providers”: Data Exchange (~5 %-10 %); Internal Development (~15 %)





Satisfaction with *Important* D/I/S Characteristics: All Sectors

- Assume the “Very Satisfied” and “Extremely Satisfied” dimensions are in the same grouping and call that Grouping *More Satisfied*
- Make a similar assumption re: “Somewhat Satisfied” and “Satisfied” and they can be referred to as *Less Satisfied*.



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Based on Phase II Survey Responses

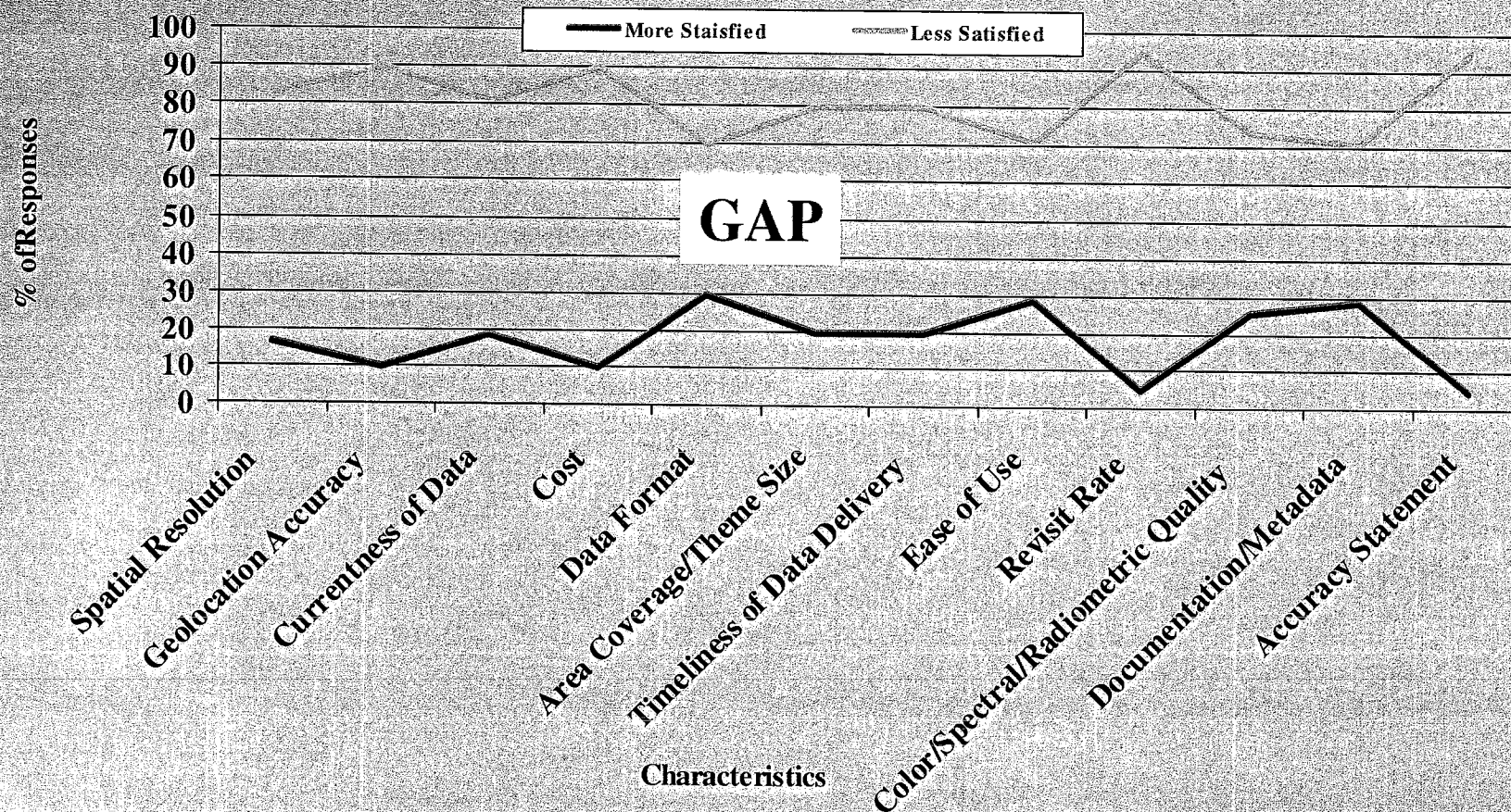
Apparently, there is room for improvement in “Satisfaction”



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Satisfaction with *Important D/V/S Characteristics*: All Sectors



This presents potential business opportunities



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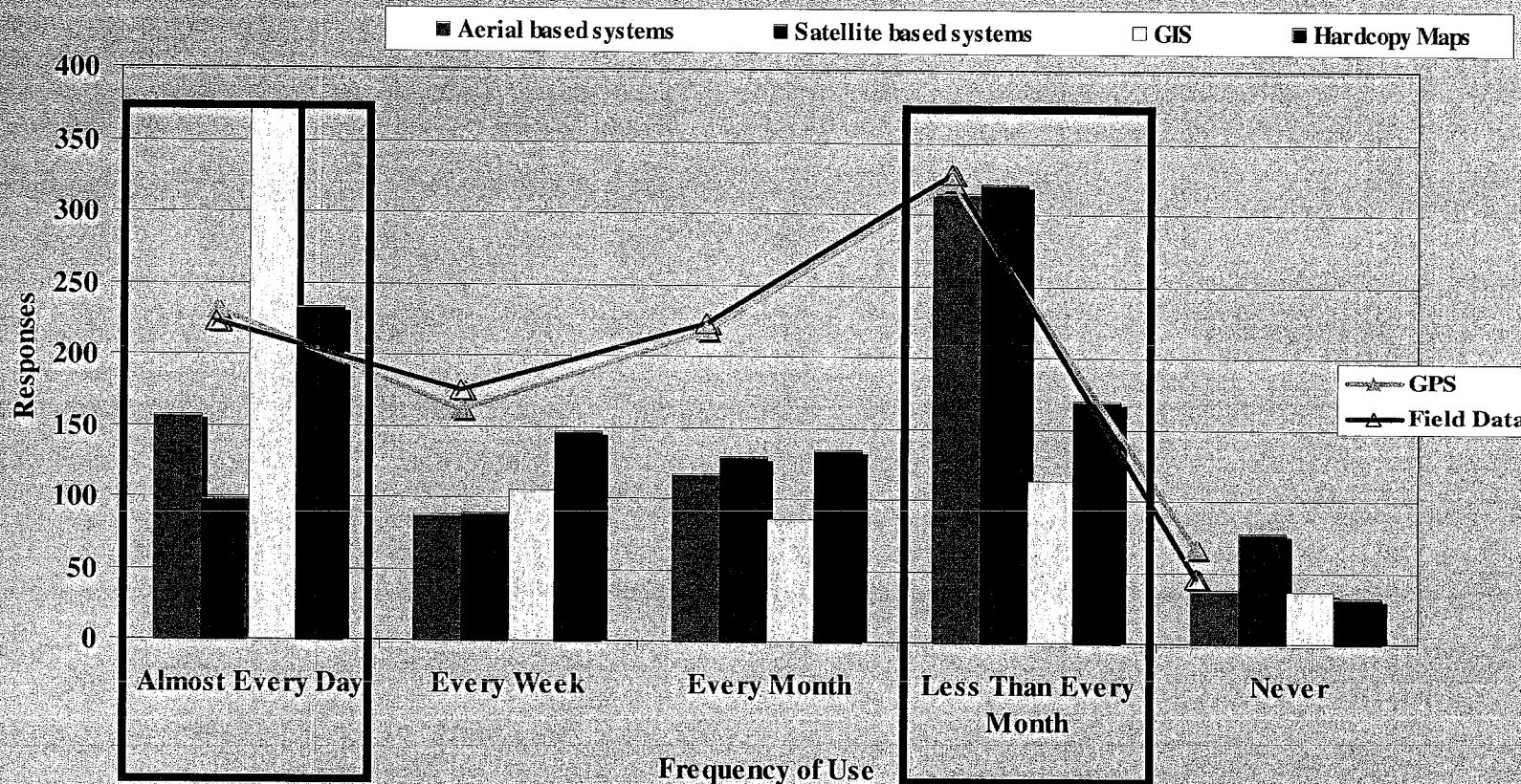
Based on Phase II Survey Responses



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How Often Data/Information by General Type is Used: All Sectors



- GIS And Hardcopy Maps are most often Used “Almost Every Day”; Satellite-based System Data / Information least
- The Bi-modality indicates some tools are frequently Used “Almost Every Day” others “Less Than Every Month
- There may be a relationship between frequency of Use and frequency of up-dates required



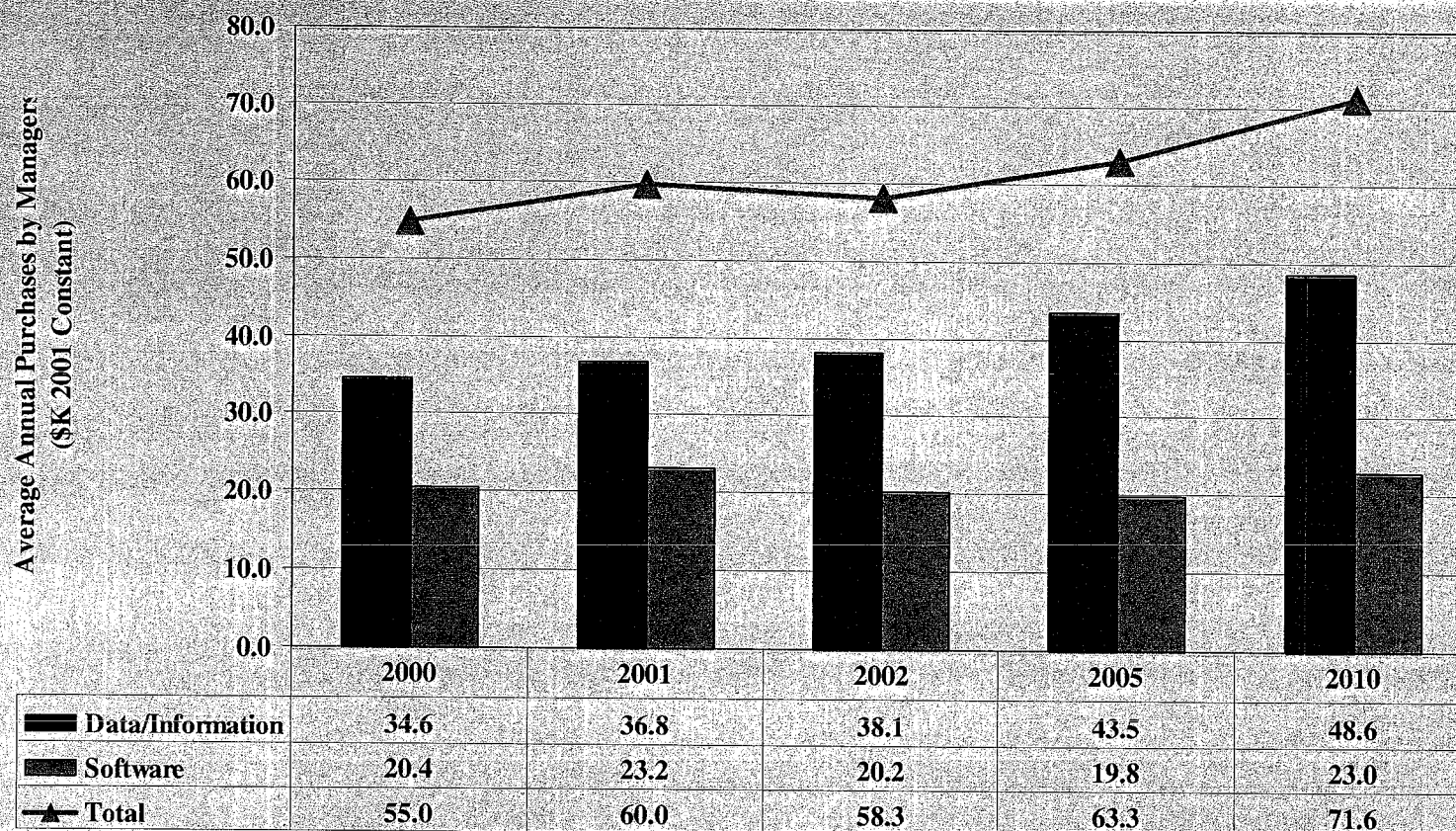
3/19/2002

Based on Phase II Survey Responses





Average Annual Purchases of Remote Sensing Data, Information and Software* Made by Managers



- Data and Information have a combined average annual growth (AAG) rate of approximately 9%
- Software purchases (which tend to be cyclical) fluctuate, however, over the total period 2000 – 2010 software purchases AAG rate is ↑ 4%



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Based on Phase II Survey Responses

*Calculated from base year 2000

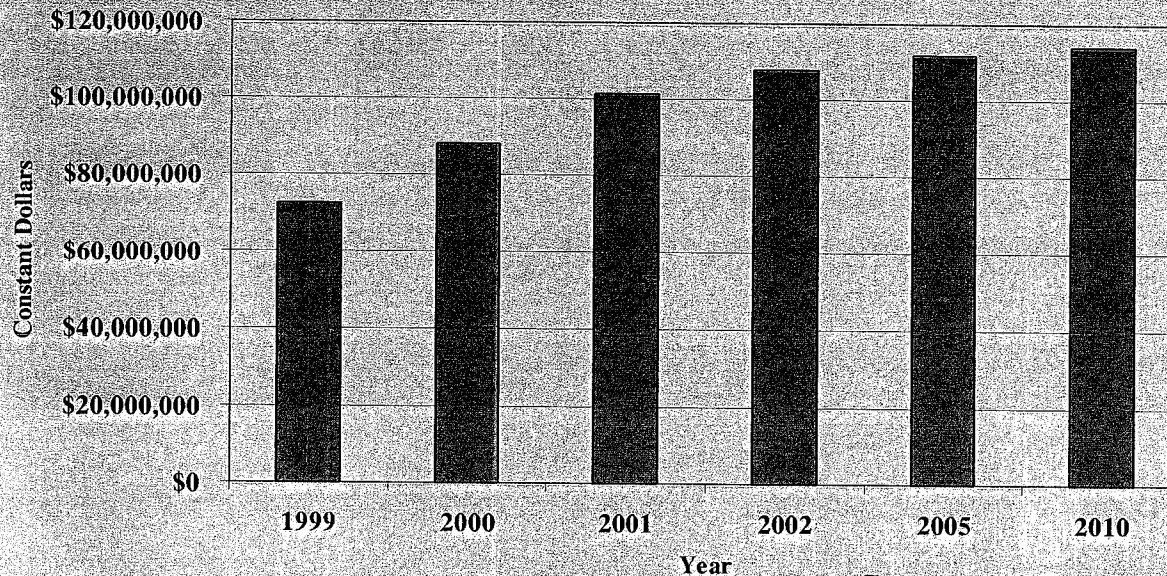


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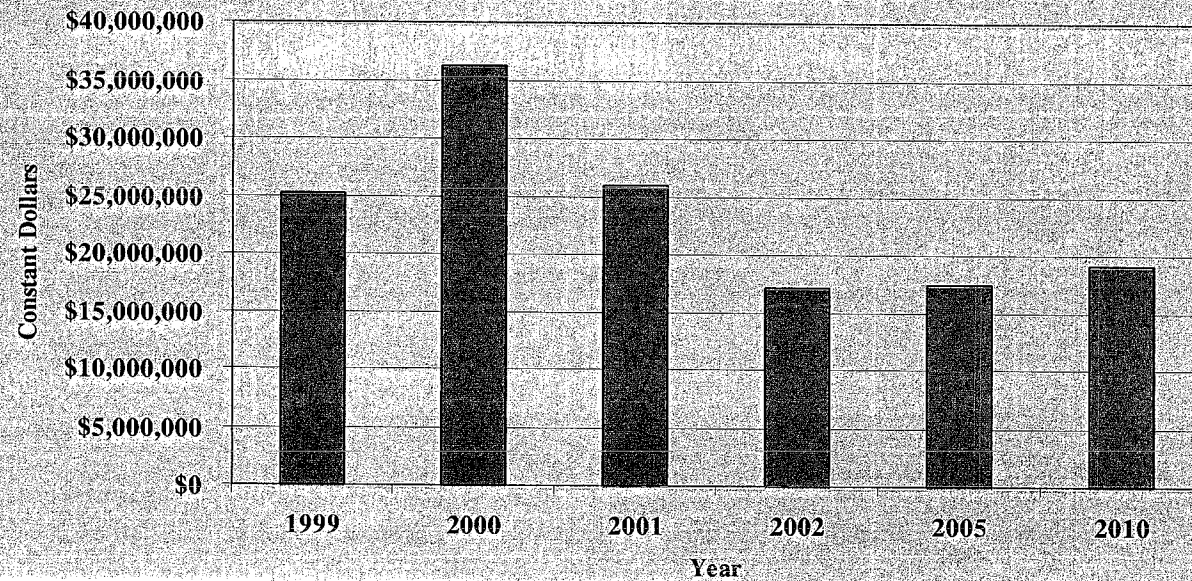


Government Purchases of D/I/S

Government - Total Purchases of Data/Information



Government Purchases of Software by Year



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Conclusions

- ✓ Our sample is large (>1,400) and the geographic distribution of our sample indicates that the data do not have a regional bias
- ✓ Participants in this analysis have the breadth and scope necessary to enhance its credibility
- ✓ Both Manager and User groups are well represented
- ✓ Data reinforces other estimates of double digit RSI growth into the next decade
- ✓ Current community of managers/users is both well educated and generally knowledgeable remote sensing
 - Very little is done by way of education and training to upgrade the workforce after formal education is completed



Based on Phase II Survey Responses

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Conclusions

- ✓ **The CRSI market is growing at about 10% per year (effects of 9/11/01???)**
 - About \$2B in 2001, growing to about \$6.5B in 2012 (Constant CY 2001\$)
 - Aerial and satellite markets do not seem to be in competition

- ✓ **The industry is fragmented and primarily populated with small companies**
 - Average Annual Revenues, CY2001: \$3.7M
 - Does not necessarily mean low entry barriers.

- ✓ **Imagery collected from aerial platforms is used 2 times more frequently than imagery collected from space platforms**





Conclusions

- ✓ High Resolution, Geo-location Accuracy, and Cost are market drivers
 - Information value is the key factor
- ✓ Digital is the preferred format
- ✓ Companies operate in more than one business segment
- ✓ Government agencies are the largest potential Customer group (about 67% of revenues through 2006 per F/S)
 - Federal and SLT interests are not the same
 - At SLT level, decisions re: the use of remote sensing products are made by elected officials (not RS/GIS professionals)
- ✓ Growth of the Remote Sensing Industry is *more* dependent on funding, user education (marketing), workforce development, and market awareness than on technology development





Conclusions

- ✓ Experience of the RSI workforce follows what seems normal trends for other industries.
 - Persons enter, some stay and the careerists become the largest group after about 9 years
 - Workforce retention is an issue
- ✓ Currently, Across All Sectors, the most Active Markets/Apps/Activities/ Market Segments are:
 - Mapping/Geography
 - Environment
 - Civil Government
 - National/Global Security (position varies with how you account for Defense programs)
 - Transportation

Opportunities in less developed Market Segments???



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Based on Phase II Survey Responses



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Conclusions

- ✓ The public and private sectors provide about the same amount of data and information products to the marketplace; the private sector is the primary provider of software
- ✓ There is a significant gap between *Spatial Resolutions* in use and what is needed. This gap is pronounced at the 1-3 feet and <6-inch levels
- ✓ There is a significant gap between *Elevation Accuracies* in use and what is needed. This gap is significant at the < 6 inch-level and pronounced at the 6-18-inch and 19-35-inch levels
- ✓ There is a significant gap between *Geo-location Accuracies* in use and what is needed. This gap is significant at the < 6 inch-level and pronounced at the 6-18-inch and 19-35-inch levels
- ✓ While Users Needs are “fairly well” met in the Application Areas, the least satisfaction is found in the most active Markets/Applications (opportunity?)





Conclusions

✓ The image types in use will shift dramatically between 2001 and 2006

Most Used in 2001 (>10%)

1. Digital B/W
2. Multispectral
3. Digital Color
4. Pan Film (Pan; B/W)
5. Color Film
6. Digital IR

Most in Use in 2006 (>10%)

1. Digital Color (3)
2. Multispectral (2)
3. LIDAR (8)
4. Digital IR (6)
4. Hyperspectral (9)
6. Digital B/W (1)

It should be noted that

- SAR use more than doubles
- Digital Color & Multispectral do not grow



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Based on Phase II Survey Responses



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